Unclass

~~CONFIDENTIAL~~

~~HQ Knobel~~ ~~2299~~ ay. 4

58-4

Room 35

Engr. Lab

Group 4

Univ. of Ill.

PRESENTATION II

ALL WEATHER ATTACK FEASIBILITY

REPORT R-92

Control Systems Laboratory

University of Illinois

April 17, 1957

Unclass

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COPY 77 OF 85 COPIES

AGENDA

Wednesday, April 17

Morning:

8:30 Registration
9:00 Welcome to the Control Systems Laboratory
W. L. Everitt, Dean of College of Engineering
9:10 Remarks: Cmdr. Ditch (BUAER)

PRESENTATION

9:20 The AWA System
A. Longacre
10:00 Coffee
10:15 Design of the AWA System
A. Longacre
11:10 Target Detection
R. Anderson
11:40 Lunch
(Convenient luncheon facilities on ground floor of the Illini Union)

Afternoon:

1:00 Target Lock-On and Terrain Avoidance
J. Rodems
2:00 Various Technical Particulars
H. Knoebel
3:00 Coffee
3:15 - 5:15 Group Conferences

Thursday, April 18

Morning:

8:30 - 11:40 Group Conferences
8:30 Departure for B-29 Equipment Demonstration at Chanute Field
(from Mathews St. entrance to Mechanical Engineering Bldg.).
10:00 Coffee
11:30 Group returns from Chanute Field
11:40 Lunch
(Convenient luncheon facilities on ground floor of Illini Union)

AGENDA (Continued)

Thursday, April 18

Afternoon:

1:00 - 5:15 Group Conferences
1:00 Departure for B-29 Equipment Demonstration at Chanute Field (from Mathews St. entrance to Mechanical Engineering Bldg.).
3:00 Coffee
4:00 Group returns from Chanute Field

Friday, April 19

Morning:

8:30 - 11:40 Group Conferences
10:00 Coffee
11:40 Lunch
(Convenient luncheon facilities on ground floor of the Illini Union)

Afternoon:

1:00 - 5:15 Group Conferences
3:00 Coffee
5:15 Adjourn

CDR DITCH
2W45

LI 5-6700
62829
63071
61489

CDR BAIRD
1W92
65708

REGISTRATION FOR CONFERENCES AND DEMONSTRATIONS

The conference hours are being offered by the Navy and the Control Systems Laboratory so that representatives of a given possible contractor may discuss confidential ideas concerning the All Weather Low-Altitude Carrier Based Attack Airplane. The conferences are:

AWA SYSTEM
Dr. Longacre

MOVING TARGET LOCK-ON AND TERRAIN CLEARANCE
Messrs Rodems and Allen

CANCELLATION, COLOR DISPLAYS AND SYSTEM TECHNICALITIES
Messrs Anderson and Knoebel

NAVY CONCEPTS
Bureau of Aeronautics Personnel

Registration for one hour conferences may be secured by signing the possible contracting firms name in the appropriate box on the bulletin board. First come, first serve, but not more than one hour may be reserved by a contractor with any given conferee.

There will be two ground demonstrations of the feasibility equipment at Chanute Air Force Base on Thursday, April 18. Departures are noted in the Agenda (pages 2 and 3). Bus transportation, accommodating up to thirty persons, will be provided by the Control Systems Laboratory.

Control Systems Laboratory secretaries will be happy to assist you with your conference departure plans.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

AWA REFERENCES

Control Systems Laboratory Reports

R-28 "A Proposed System For All Weather Attack on Moving Vehicles"

R-31 "A Non-Coherent Doppler Automatic Tracking Airborne Radar For Use On Ground Targets"

R-57 "All-Weather-Attack System"

I-57 "Drawings Applicable To CSL All Weather Attack System"

AWA - Test Equipment:

I-46 "Moving Target Video Signal Generator"

I-66 "Universal Butterfly Circuits"

Since these references are in short supply, it will be necessary to limit them to one per firm. Copies may be obtained by formal request, including a certified need to know, to the Military Liaison Officer, Major R. A. Kirkpatrick, Control Systems Laboratory, University of Illinois, Urbana, Illinois. Requests for more than one copy of a report may be filed, but second copies will not be forwarded before May 1, 1957, and then only if the supply permits.

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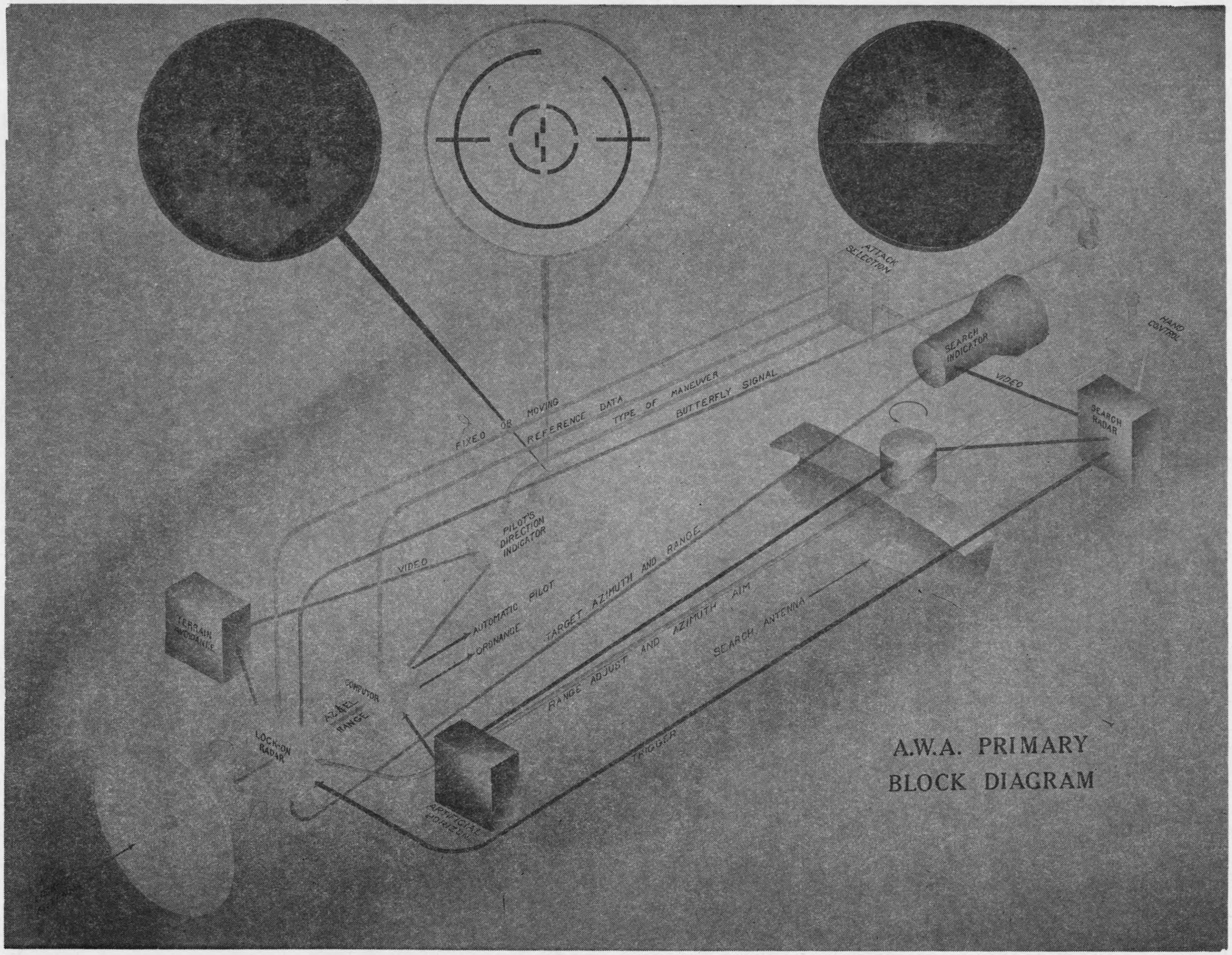

A.W.A. PRIMARY
BLOCK DIAGRAM

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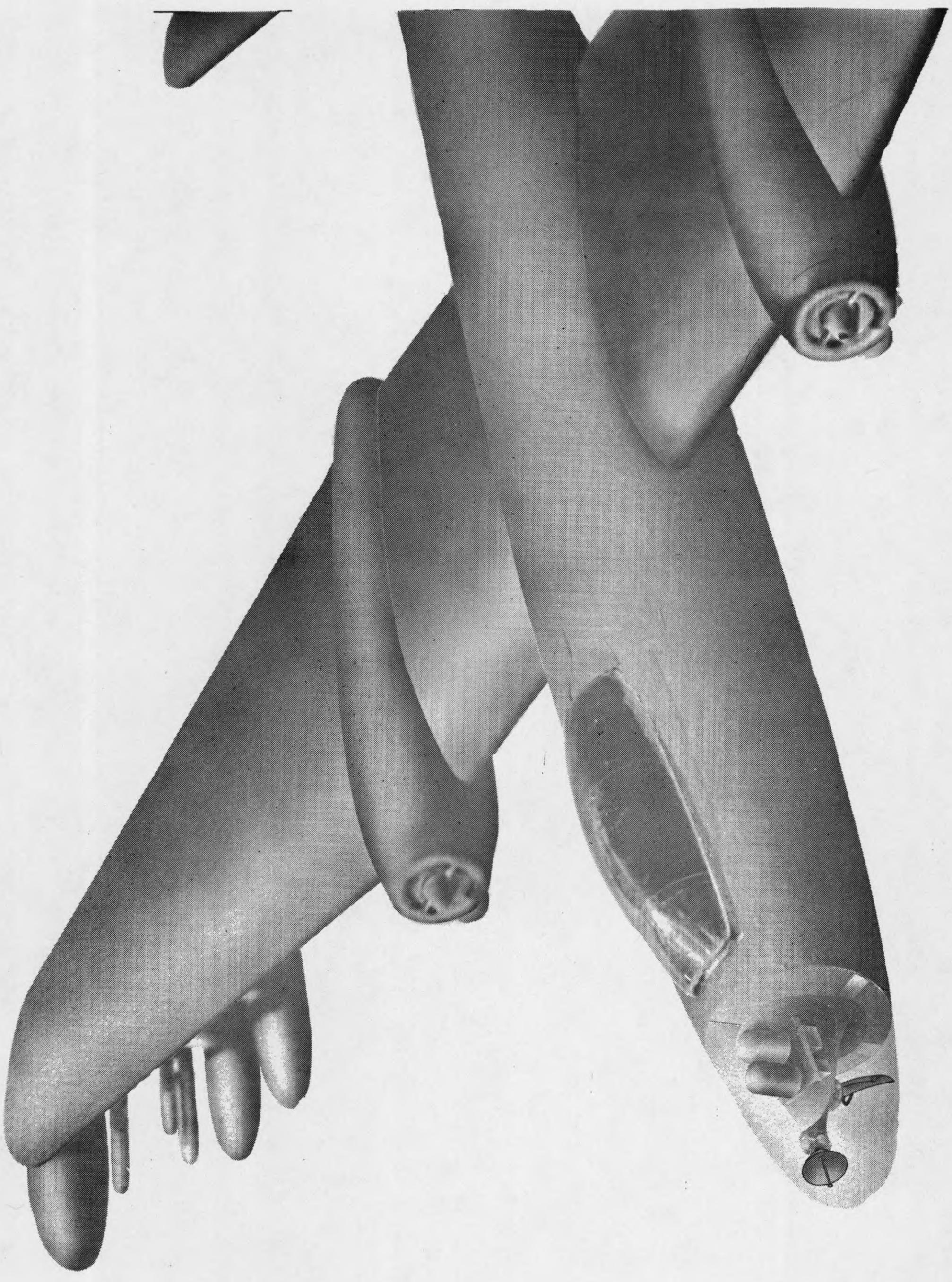
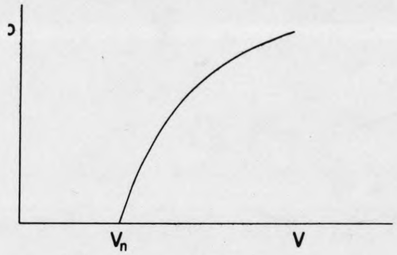
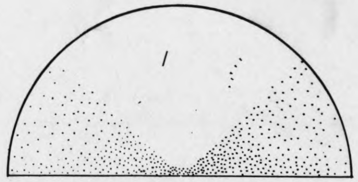
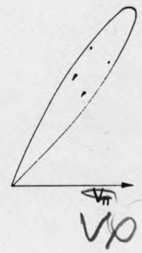


MTI LIMITATIONS







$v_n = \lambda^{3/2} f_r L^{-1/2} K = 2.96$ mi/hr

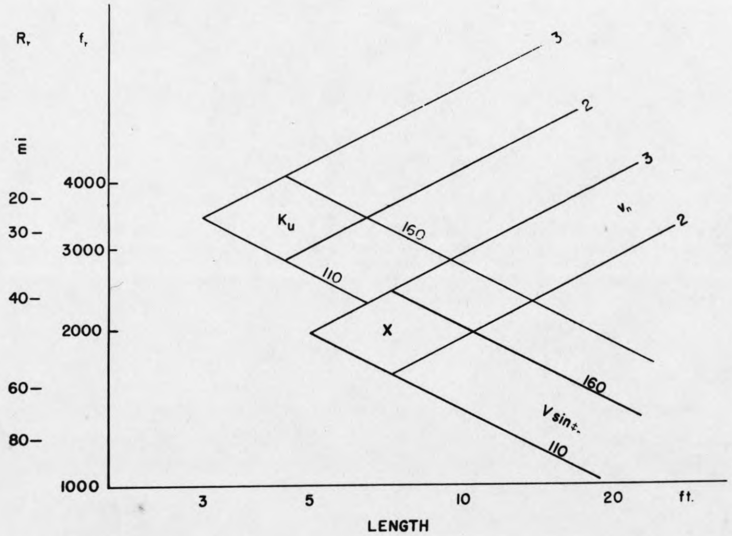
$$K = \frac{1}{4\pi}\left(\frac{\Delta S_0}{\beta}\right)\sqrt{\frac{\sigma_0 c \tau h}{\sigma}}$$

v_n	3	5	8	10
p	.1	.5	.75	.9

$$V \sin\phi_n = \frac{V_n L}{\lambda}\sqrt{\frac{\sigma}{\sigma_c}} = 110.\ \text{mi/hr}$$

$$\sqrt{\frac{\sigma}{\sigma_c}} = .78$$

V	200	400	600
ϕ_n	34°	16°	10°



$V\sin\phi_n$ \ V	200	400	600
110	33.6°	16.0°	10.6°
160	53.1°	23.6°	15.5°

csc^2 ANTENNA

$P_{rt} \propto L P_t \sigma / h^2$

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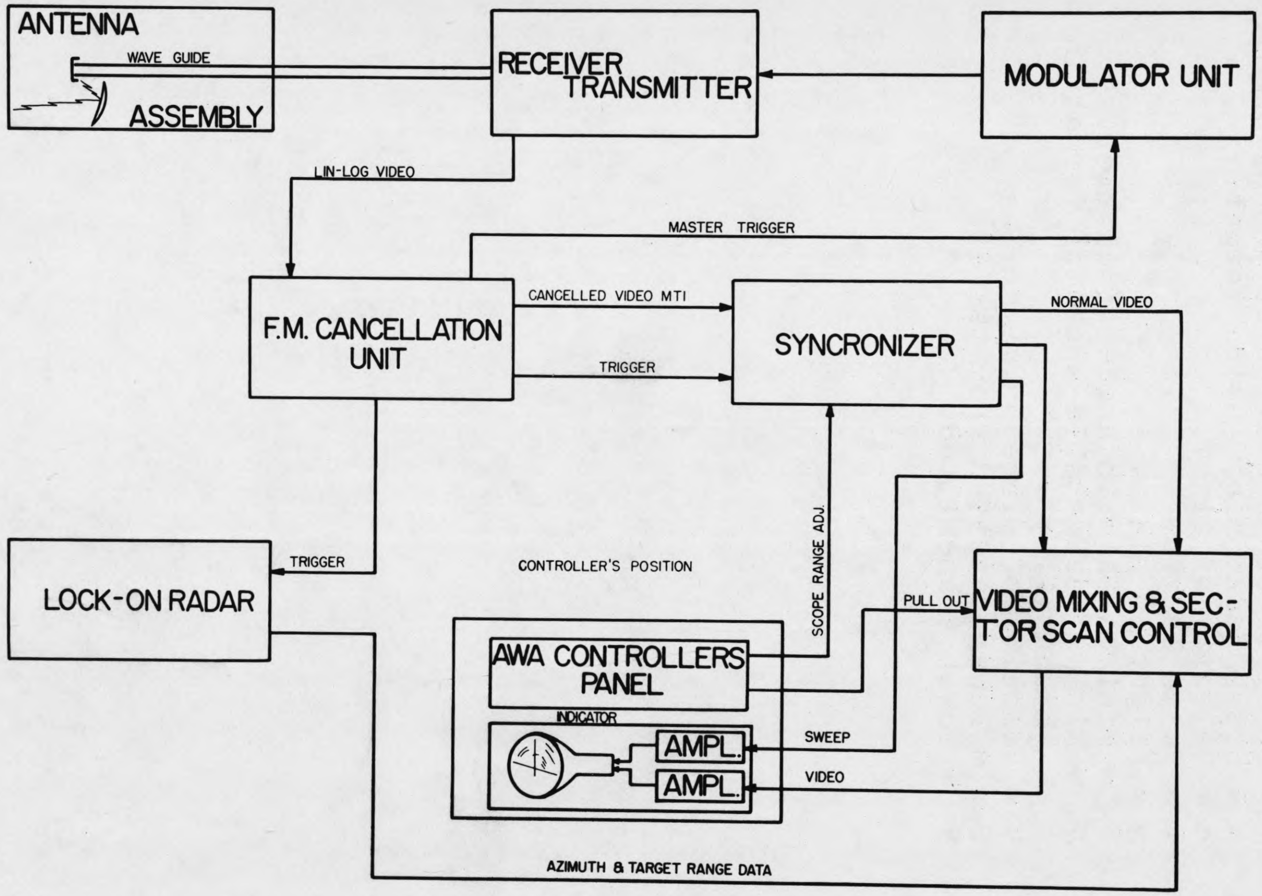
λ = Wave length of detecting radiation in cm.
f_r = Pulse recurrence frequency in P.P.S.
L = Length of Antenna in feet.
ΔS_o = Threshold difference level in signal.
β = Logairthmic receiver coefficient.
σ_g= Specific cross section of ground signals (sq. ft./sq. ft.).
σ = Cross section of moving target.
c = Velocity of light.
τ = Pulse length.
h = Height of plane.
φ_n = Minimum azimuth angle of clutter.
V_n = Minimum detectable speed of target in mi/hr.
(probability = 0)
V = Velocity of plane in mi/hr.
P_{rt} = Power received from target.
P_t = Power transmitted.

AWA SEARCH & MONITOR RADAR FUNCTIONAL DIAGRAM



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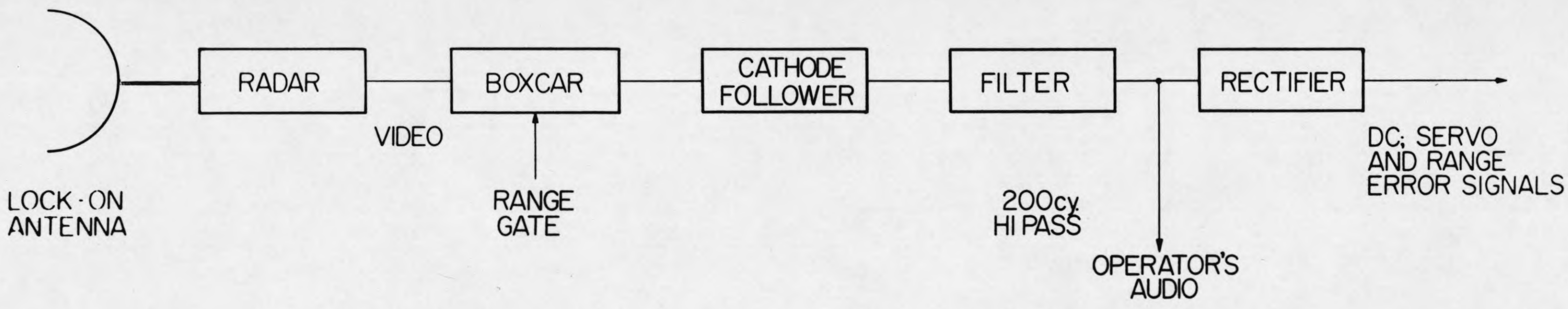
BLOCK DIAGRAM OF BUTTERFLY TRACKING CHANNEL



FOR THE MONOPULSE TRACKING RADAR
SIX IDENTICAL CHANNELS ARE REQUIRED

[UP
DOWN]

[LEFT
RIGHT]

[EARLY
LATE]

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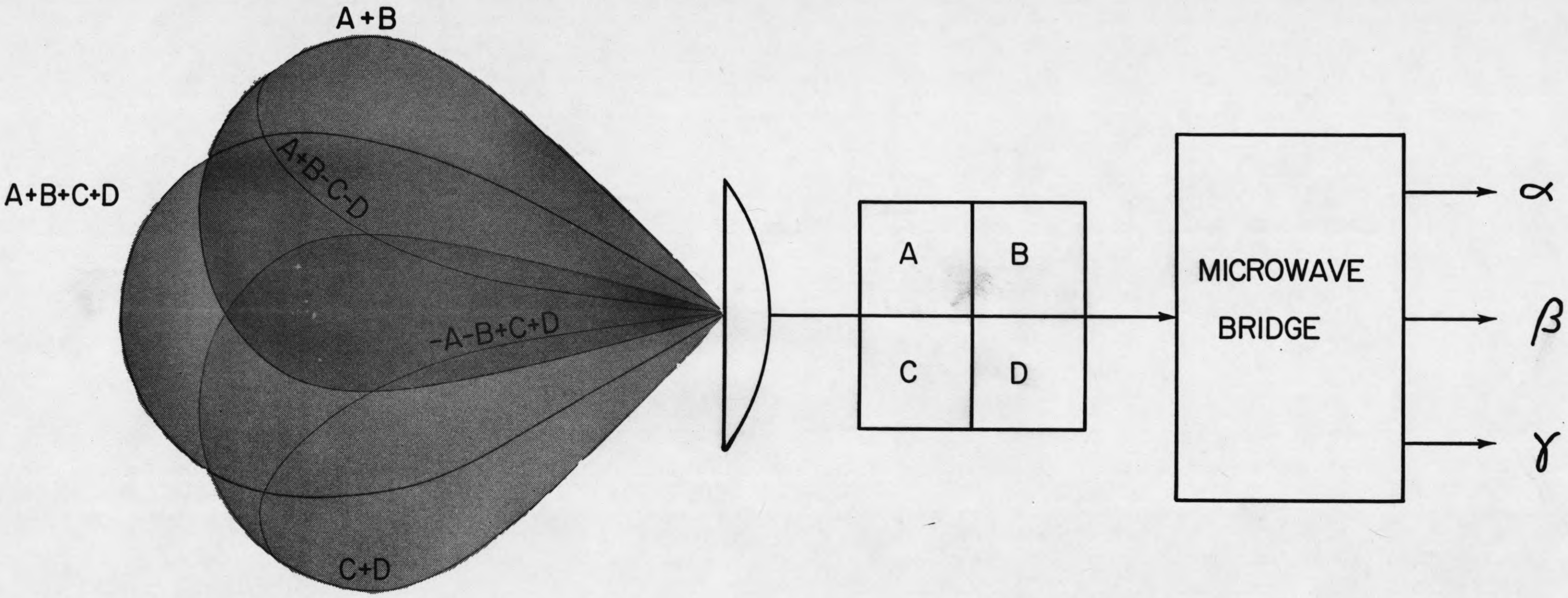
DERIVATION OF MTI ERROR SIGNALS FROM MONOPULSE ANTENNA

MONOPUSE



SUM, r.f.	α	$= A+B+C+D$
AZIMUTH r.f. ERROR	β	$= A+B-C-D$
ELEVATION r.f. ERROR	γ	$= A+C-B-D$
RIGHT TARGET SIGNAL	μ	$= \alpha + \beta$
LEFT TARGET SIGNAL	ν	$= \alpha - \beta$
AZIMUTH ERROR	Δ	$= \mu - \nu$

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MONOPULSE ALGEBRA

C	A
D	B

R.F. ERROR SIGNAL:

$\alpha - K_1(A+B+C+D)$ SUM

$\beta - K_2(A+B-C-D)$ AZIMUTH

$\delta - K_3(A+C-B-D)$ ELEVATION

AZIMUTH D.C. TARGET SIGNAL:

$$\mu - K_R(\alpha+\beta) = K_R[K_1(A+B+C+D) + K_2(A+B-C-D)]$$

$$\nu - K_L(\alpha-\beta) = K_L[K_1(A+B+C+D) - K_2(A+B-C-D)]$$

AZIMUTH ERROR SIGNAL:

$$\Delta - \mu-\nu - K_1(K_R - K_L)(A+B+C+D) + K_2(K_R + K_L)(A+B-C-D)$$

IF $K_R = K_L$ (GAINS OF VIDEO-AUDIO CHANNELS)

THEN $\Delta - K_2(K_R + K_L)(A+B-C-D)$ THUS RECEIVER GAINS DO NOT HAVE TO BE MATCHED.

K_1, K_2, & K_3 ARE RECEIVER GAINS. K_R & K_L ARE VIDEO & AUDIO GAINS.

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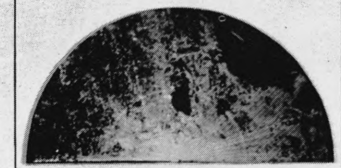
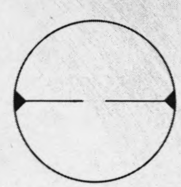
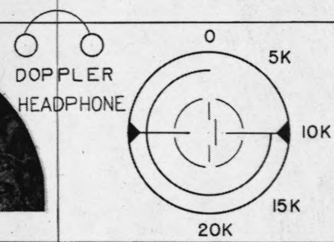
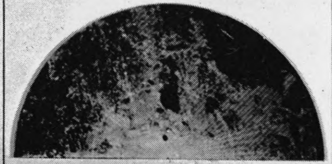
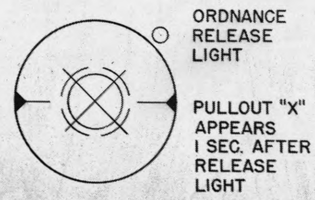
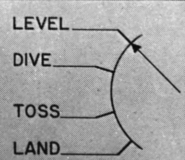
A.W.A. SYSTEM OPERATIONAL PROCEDURE

	CONTROLLER	PILOT	CONTROLLERS P.P.I.	PILOT'S SCOPE
TARGET DETECTION	NAVIGATES. SELECTS TARGET.	MONITORS TERRAIN CLEARANCE.		
TARGET ACQUISITION	GRASPS HAND CONTROL. DEPRESSES ACTION SWITCH. LOCKS ON GROUND IN EL. CONTROLS RANGE AND AZIMUTH. HEARS DOPPLER TONE. RELEASES ACTION SWITCH FOR AUTO.-TRACK.	WAITS FOR DOPPLER TONE IN HEADSET. MAINTAINS LEVEL FLIGHT.		
TARGET TRACKING	MONITORS TRACKING RUN. EXPANDS SCOPE DISPLAY. STUDIES SCOPE FOR TERRAIN AVOIDANCE DATA.	STEERS AIRCRAFT TO ZERO STEERING SIGNALS.		
ORDNANCE RELEASE	PREPARES TO REPEAT SEQUENCE.	PULLS AWAY FROM TARGET. TERRAIN AVOIDANCE PICTURE COMING NEXT.		

NOTE: SYSTEM AUTOMATICALLY REVERTS TO TARGET DETECTION MODE UPON:
(a) ORDNANCE RELEASE
(b) LOSS OF TARGET BY LOCK-ON RADAR
(c) INTENTIONAL ABORT BY OPERATOR



CONTROLLER'S ATTACK SELECTOR

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TURN AND APPROACH

V = 400 KNOTS

T_A = 20 SEC.

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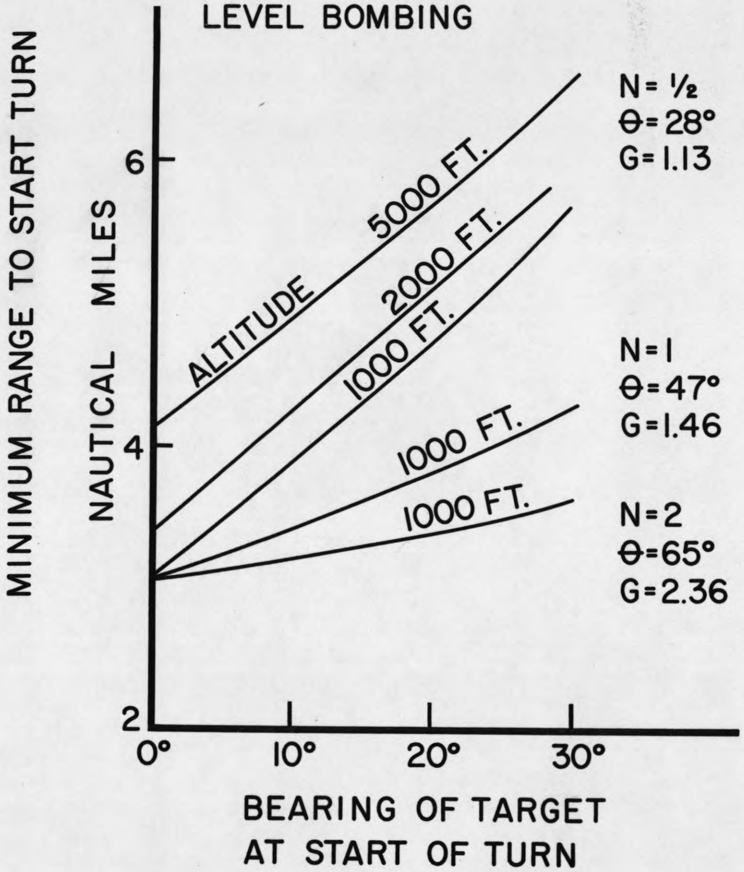

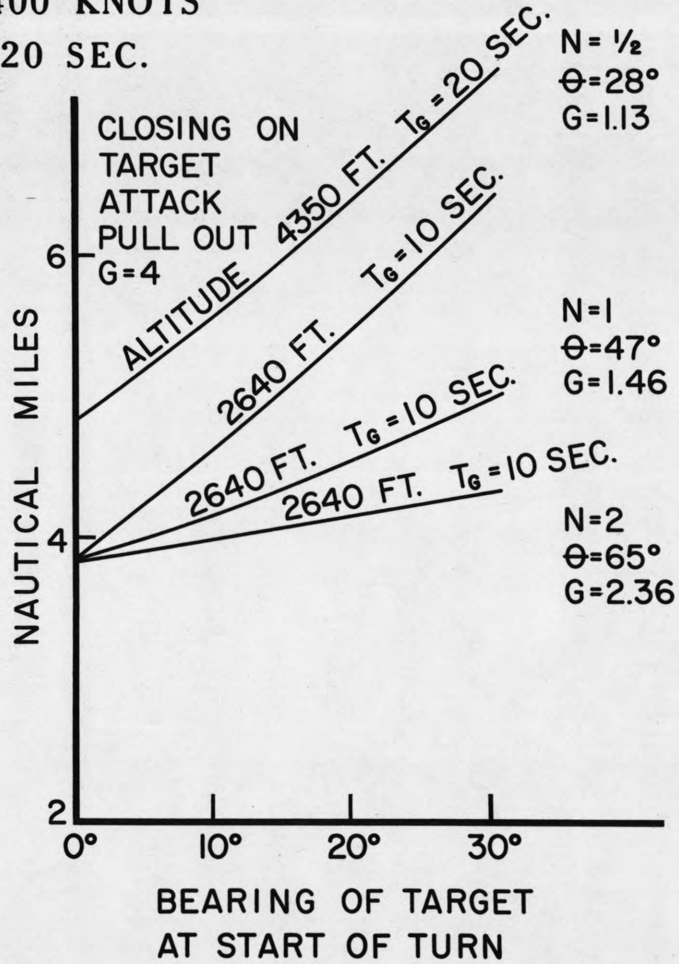

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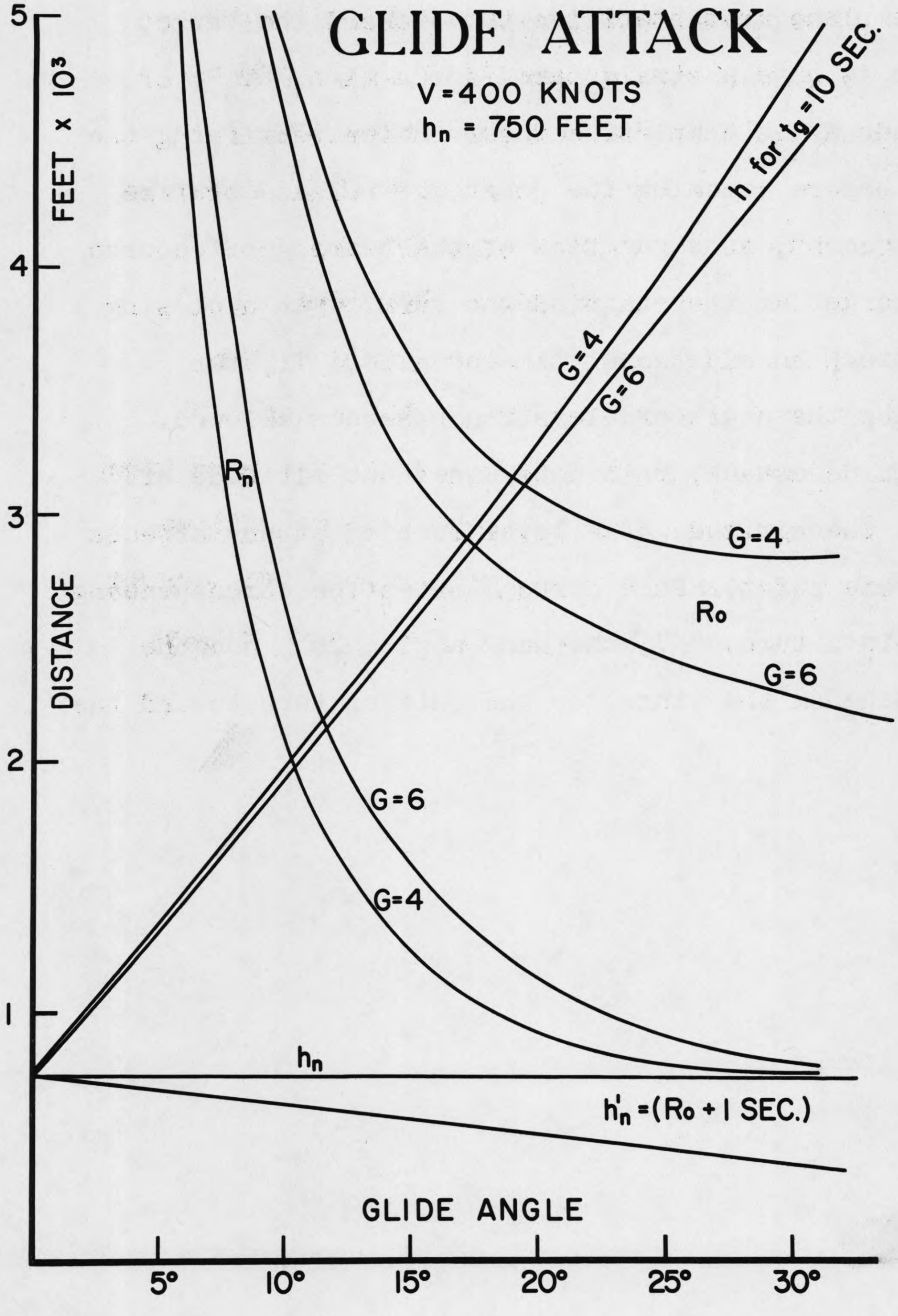
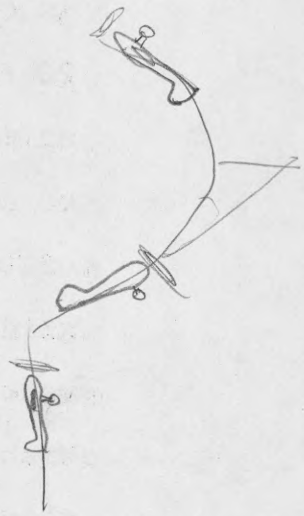
Plots the minimum distance from a target that a 400 knot plane must start its turn toward the target in order to have a straight run for a time, "T_A", of 20 seconds after completing the turn for rectifying the azimuth before reaching the point for release or fire of an armament, as a function of the bearing off course of the target at the start of the turn. For a closing glide attack an additional time of glide, T_G, for rectifying the angle of elevation has been allowed. With a glide attack, this determines the altitude of flight. The altitude of a level bombing attack affects the release point. Each curve carries the corresponding needle width turn, "N", the bank angle, "θ", and the "G" loading on the wings for the rate of turn toward the target.

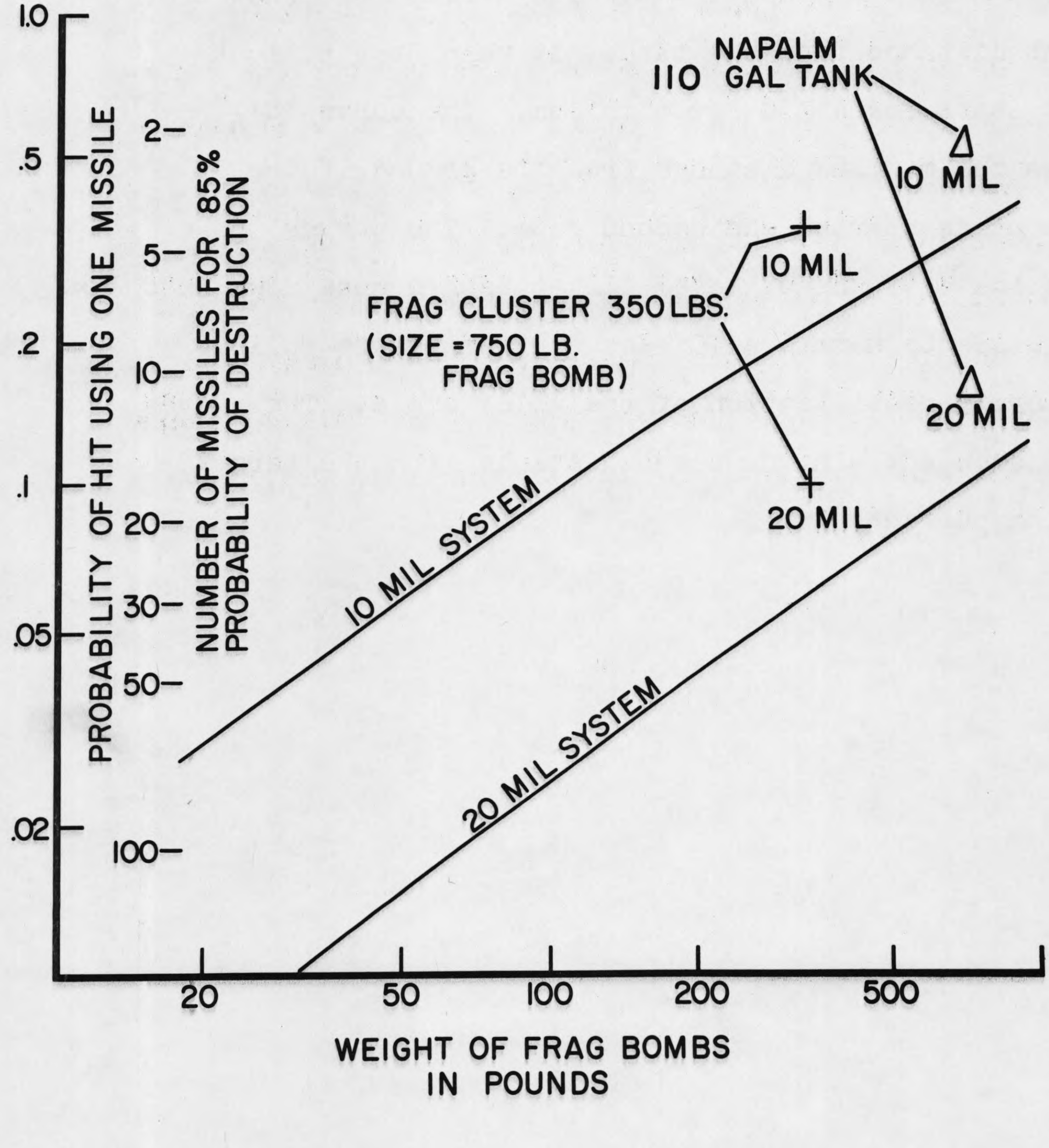

GLIDE ATTACK
V=400 KNOTS
h_n = 750 FEET
DISTANCE FEET x 10³
5
4
3
2
1
h for t_g = 10 SEC.
G=4
G=6
R_n
G=4
R_o
G=6
G=6
G=4
h_n
h'_n = (R_o + 1 SEC.)
GLIDE ANGLE
5°
10°
15°
20°
25°
30°



The pertinent distance parameters of a glide attack are shown as a function of the glide angle for a 400 knot plane and a planned minimum distance from the ground of 750 feet during the pullout for pullouts of G = 4 and G = 6. The curves "R_o" show the slant distance from the target at which the pullout must start for a 750 foot minimum. The curve "h'_n" shows the minimum distance from the ground if the pullout is started one second late. The curves "h" show the altitude of level flight before nose down into the glide to permit a 10 second glide before pullout to permit rectification of the glide angle. The curves "R_n" show the minimum slant distance from the target during pullout.

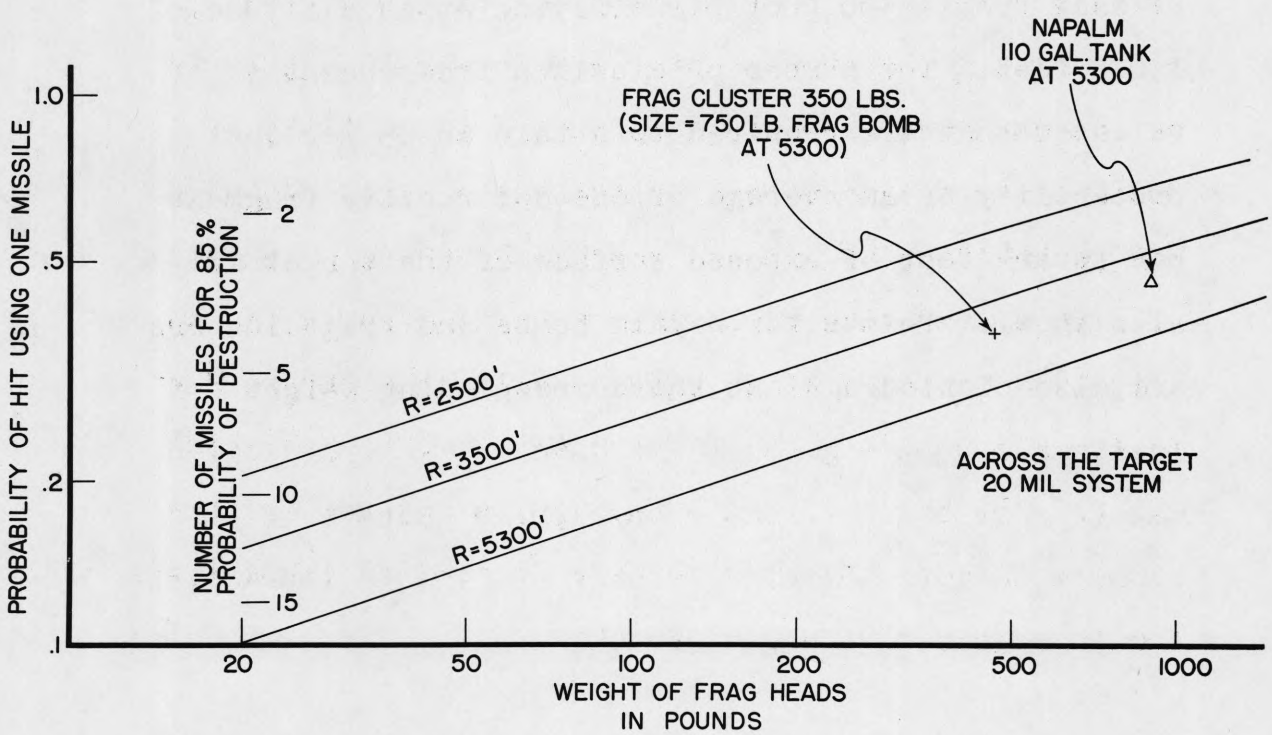
SINGLE VEHICLE DESTRUCTION

R=5300 FEET



Shows the probability of a hit by an average of one fragment per square foot of exposed surface of essentially a point target from a fragmentation bomb or H. E. head, as a function of the weight of the head when fired or released at a range of 5,300 feet from the target. 5,300 feet is the range appropriate for release from a 400 knot plane flying at an altitude of 1,000 feet. The number of missiles independently released that are required to attain an 85 per cent probability of an average of one destructive fragment per square foot of exposed surface of the target is also shown. Points for napalm bombs and frag clusters are also plotted against the corresponding weight loadings.

CONVOY OR TRAIN DESTRUCTION



The probability of attaining an average of one hit per square foot of exposed surface on some portion of an extended target by a destructive fragment from a frag head is shown as a function of the weight of the frag head for various release or fire ranges with a 20 mil system. 5,300 feet is the range appropriate for level bombing with a 400 knot plane at 1,000 feet altitude. The number of missiles independently fired or released required for 85 per cent probability of a destructive fragment per square foot are also shown. The probability of hit for a single release or burst of fire is expected to be less for an attack along a target as compared to an attack across the target due to the glancing angles of the attack. This reduction may be more than off-set with rippled release or fire along a target. Rippled release or fire is impractical for an across-the-target attack.

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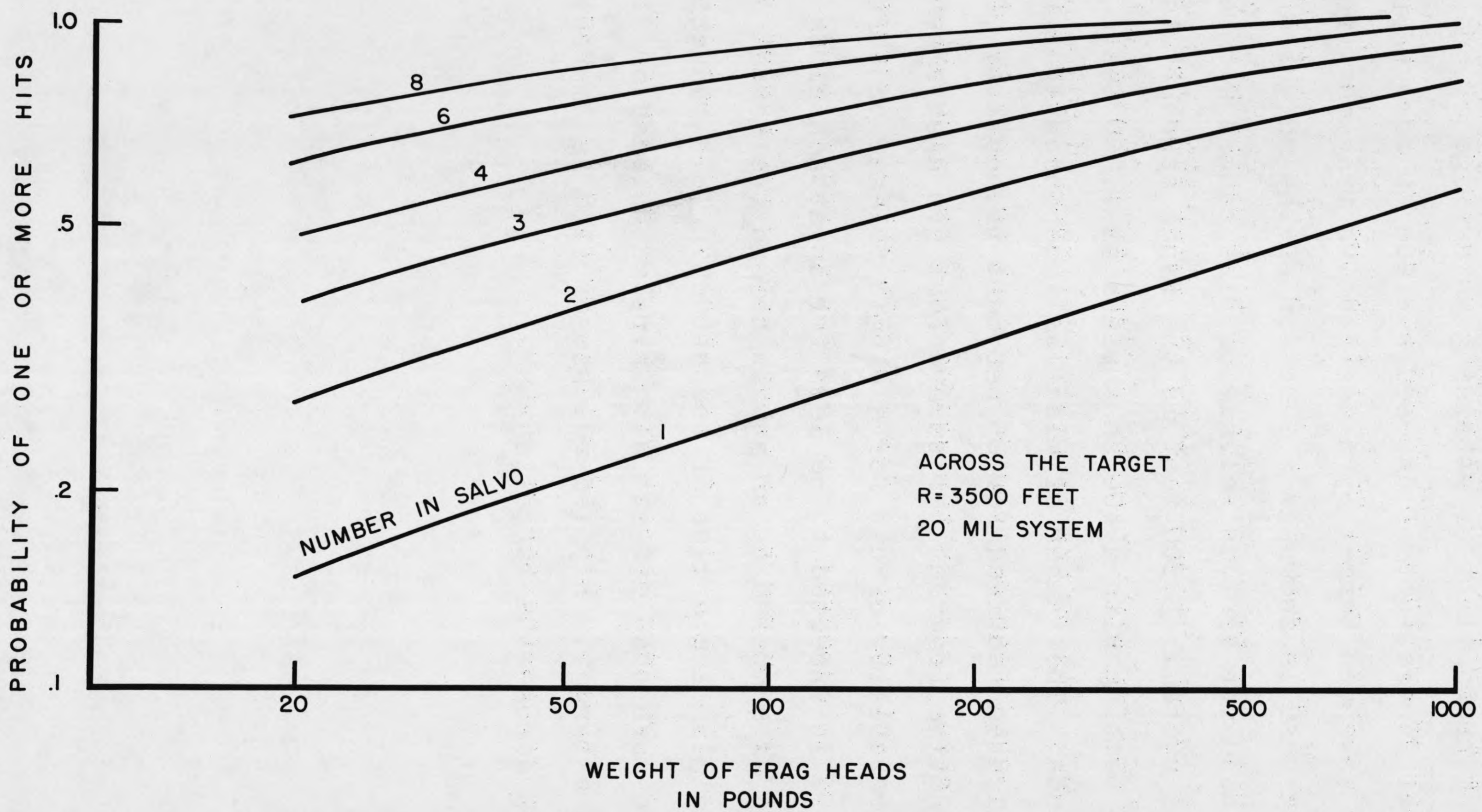
SALVO ATTACK ON CONVOY OR TRAIN



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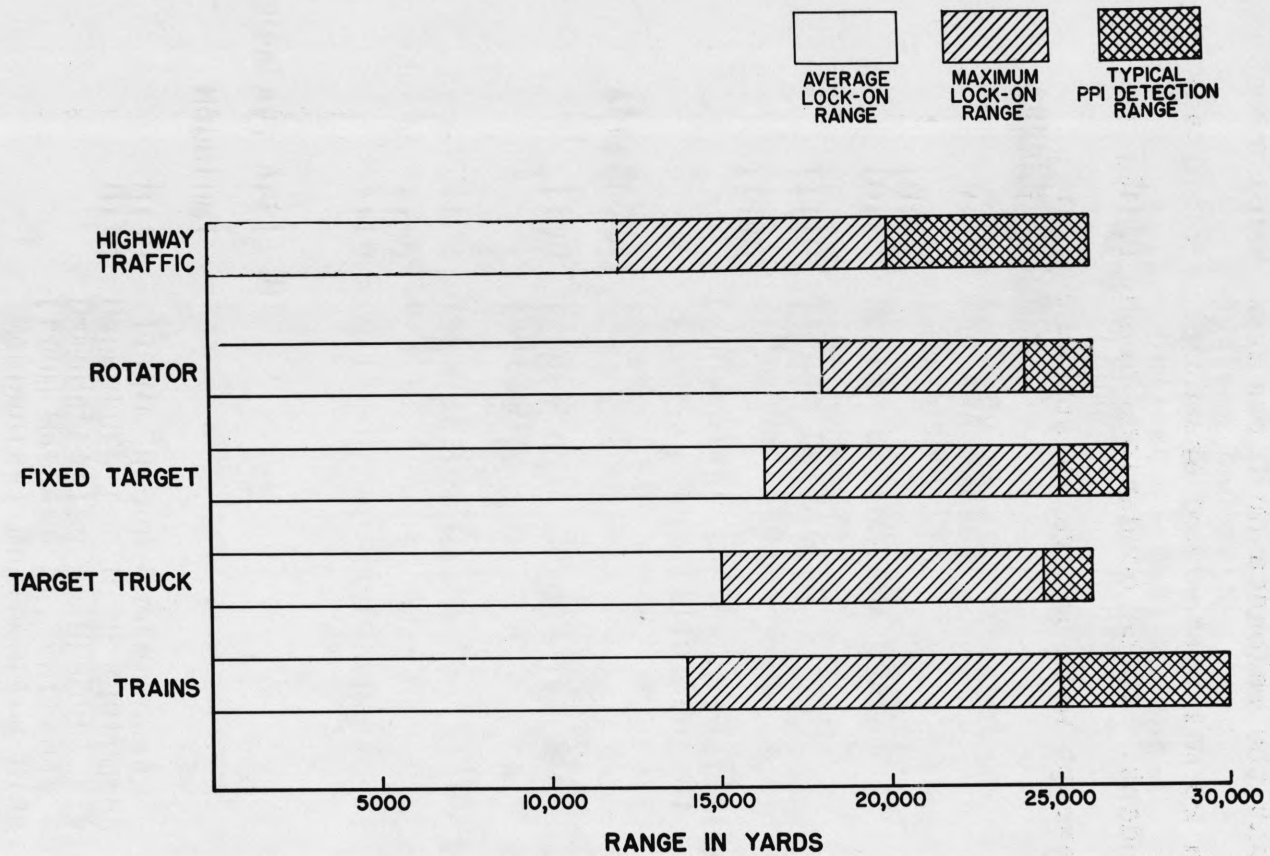
The probability of an average of one destructive fragment per square foot of exposed target for an extended target is shown as a function of the weight of the frag heads for salvos of from 1 to 8 missiles. The assumption has been made that the releases or fires from the correct aim point with a 20 mil system are essentially simultaneous and independent. These conditions are unlikely to be realized except with laterally spaced rockets.



AVERAGE AND MAXIMUM LOCK-ON AND TYPICAL PPI DETECTION RANGES FOR FIVE PRINCIPAL TARGET CATEGORIES. (AVERAGES BASED ON 81 TARGET RUNS)

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A.W.A. SYSTEM OPERATIONAL PROCEDURE

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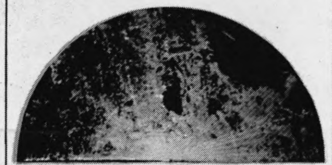
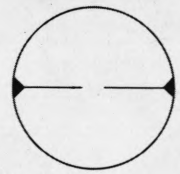
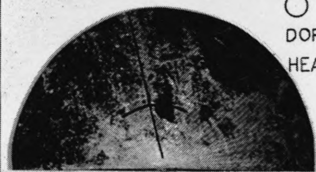
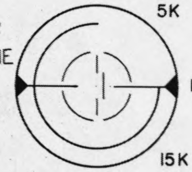
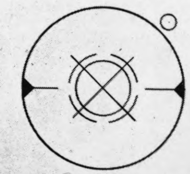
TARGET DETECTION	NAVIGATES. SELECTS TARGET.	MONITORS TERRAIN CLEARANCE.		
TARGET ACQUISITION	GRASPS HAND CONTROL. DEPRESSES ACTION SWITCH. LOCKS ON GROUND IN EL. CONTROLS RANGE AND AZIMUTH. HEARS DOPPLER TONE. RELEASES ACTION SWITCH FOR AUTO.-TRACK.	WAITS FOR DOPPLER TONE IN HEADSET. MAINTAINS LEVEL FLIGHT.		
TARGET TRACKING	MONITORS TRACKING RUN. EXPANDS SCOPE DISPLAY. STUDIES SCOPE FOR TERRAIN AVOIDANCE DATA.	STEERS AIRCRAFT TO ZERO STEERING SIGNALS.		 
ORDNANCE RELEASE	PREPARES TO REPEAT SEQUENCE.	PULLS AWAY FROM TARGET. TERRAIN AVOIDANCE PICTURE COMING NEXT.		

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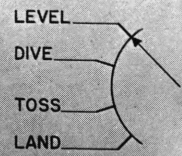

CONTROLLER'S ATTACK SELECTOR

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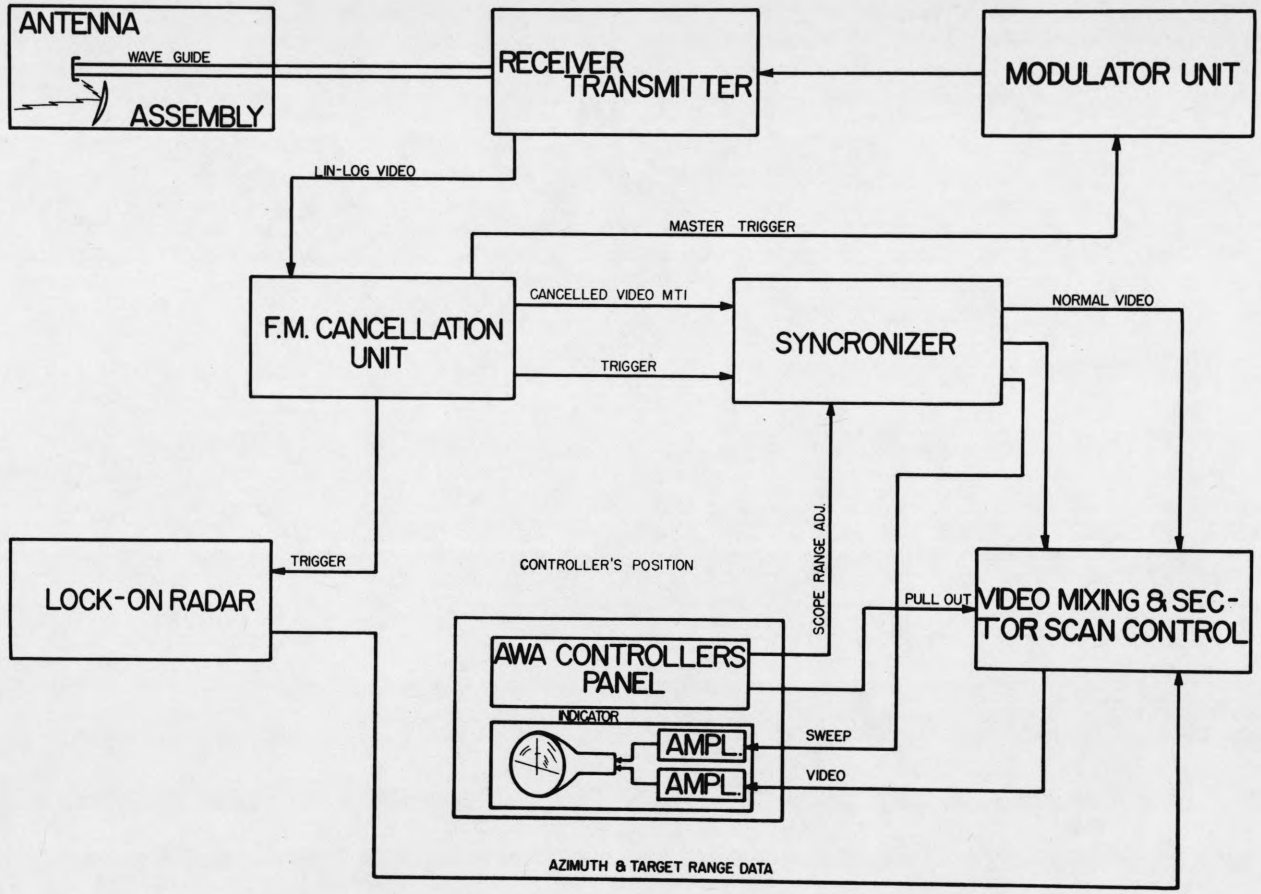
AWA SEARCH & MONITOR RADAR FUNCTIONAL DIAGRAM



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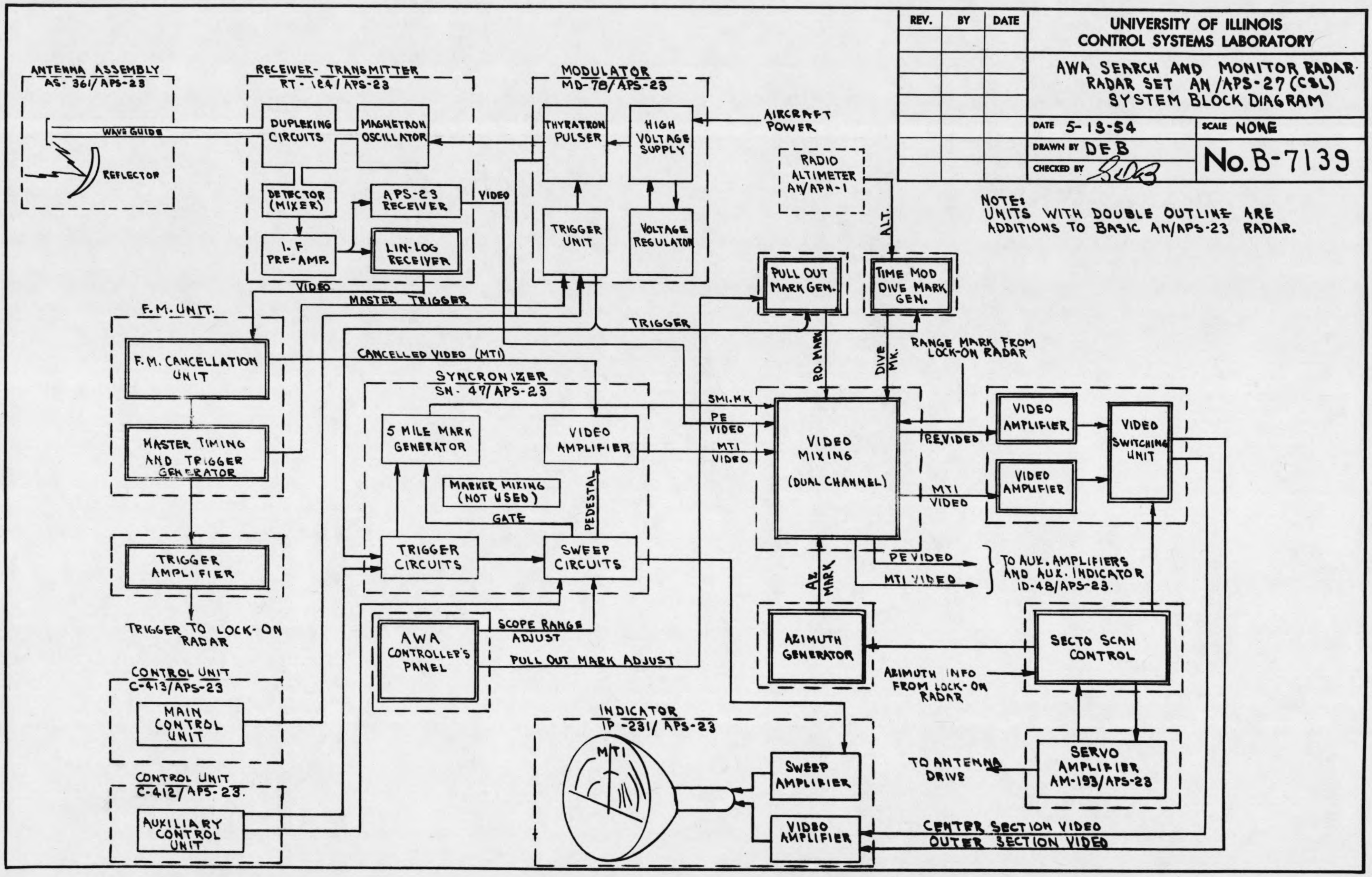

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BLOCK DIAGRAM OF F. M. CANCELLATION

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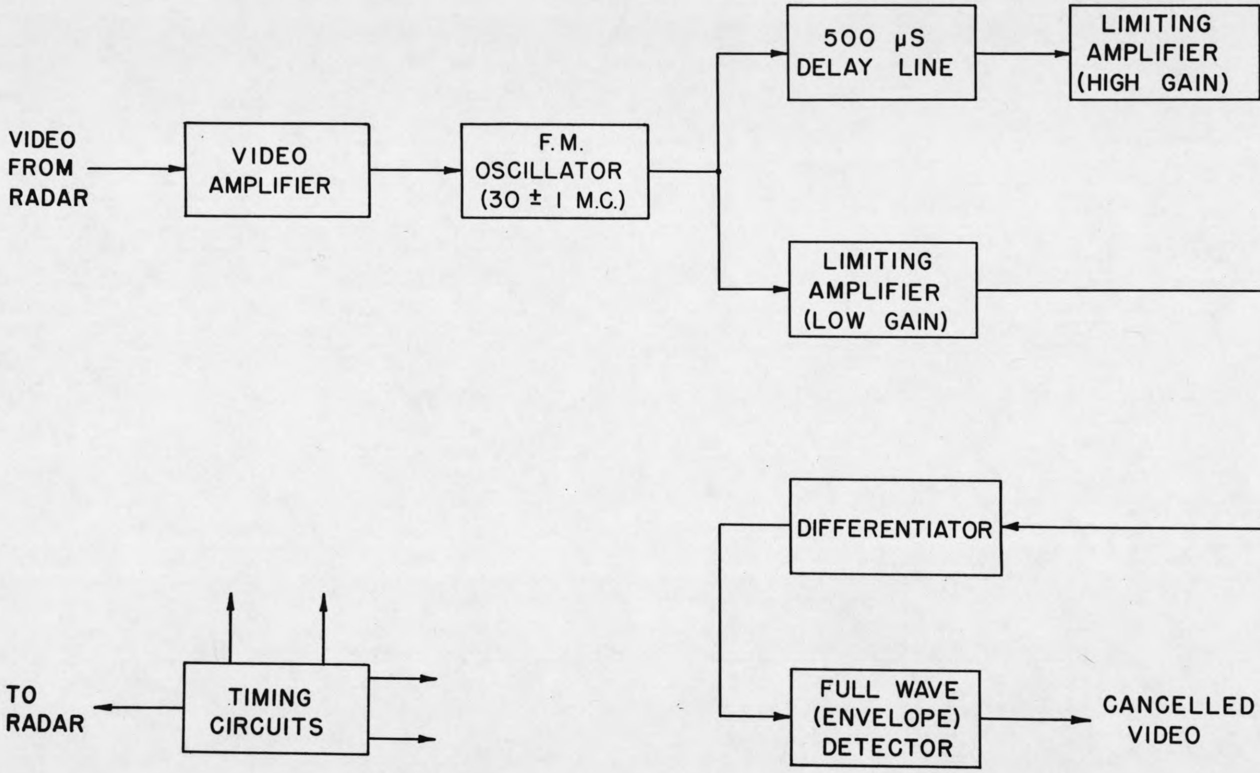
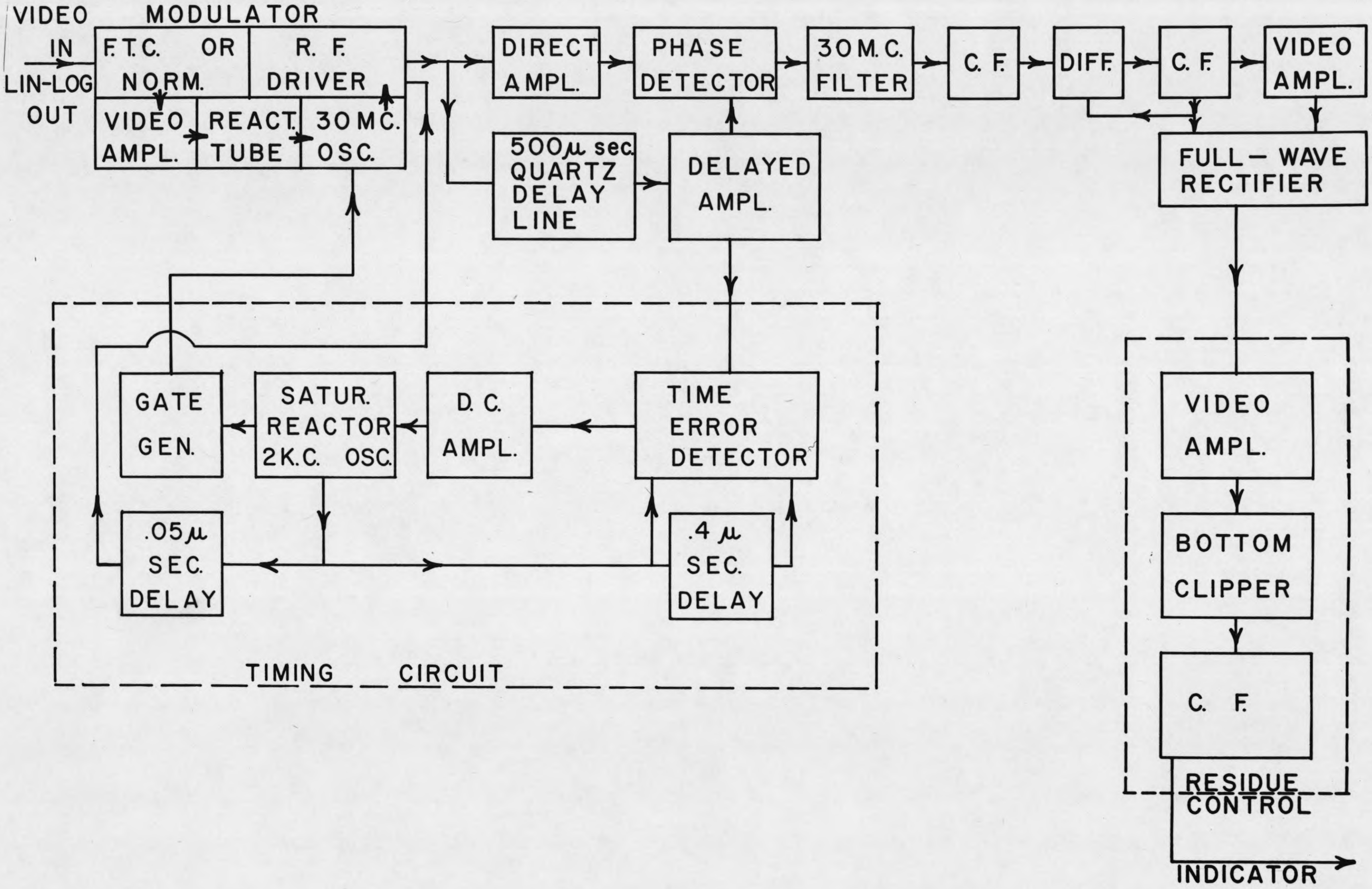


CONFIDENTIAL

FUNCTIONAL BLOCK DIAGRAM OF FM CANCELLATION

CONFIDENTIAL



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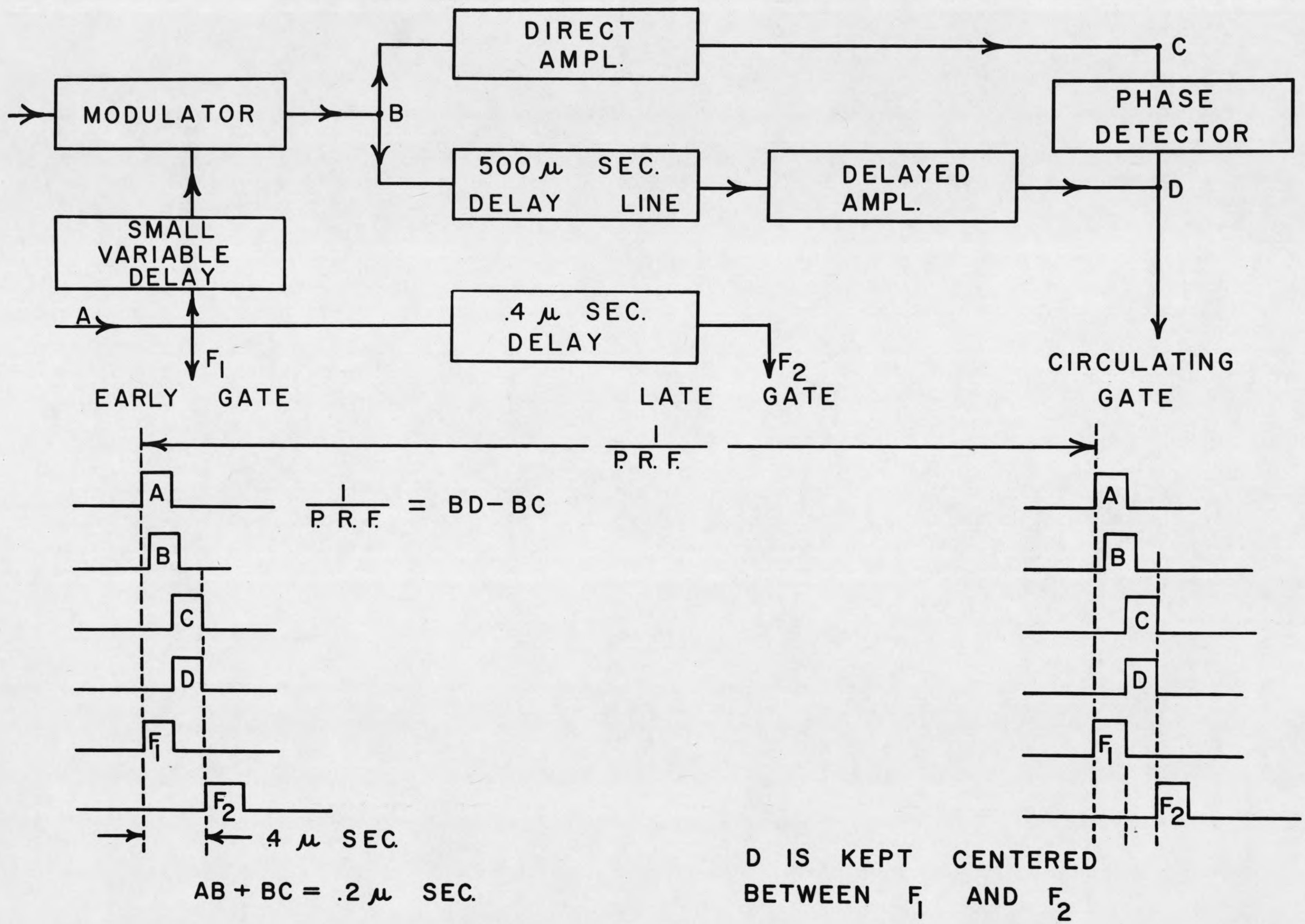
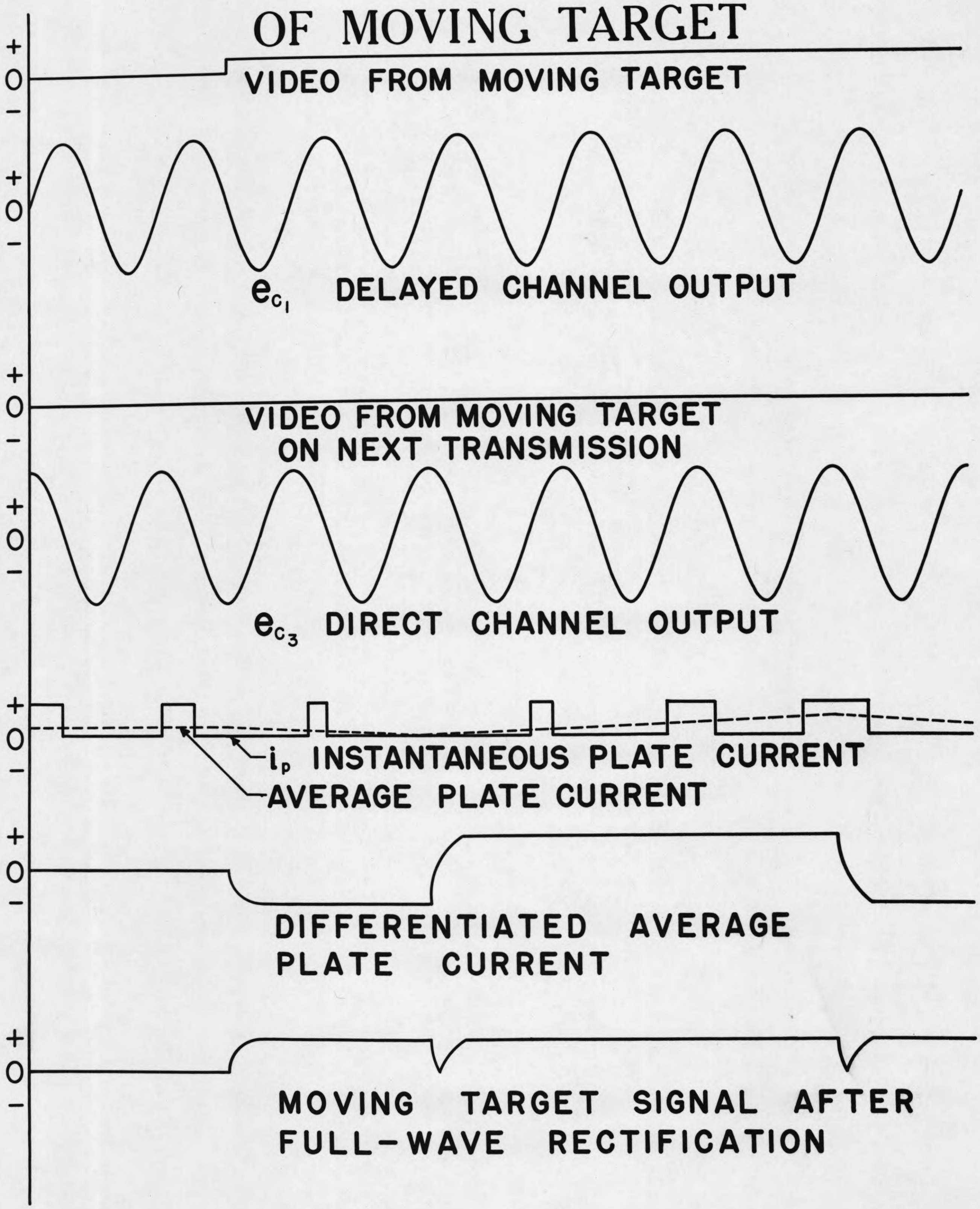
TIMING SYNCHROGRAM

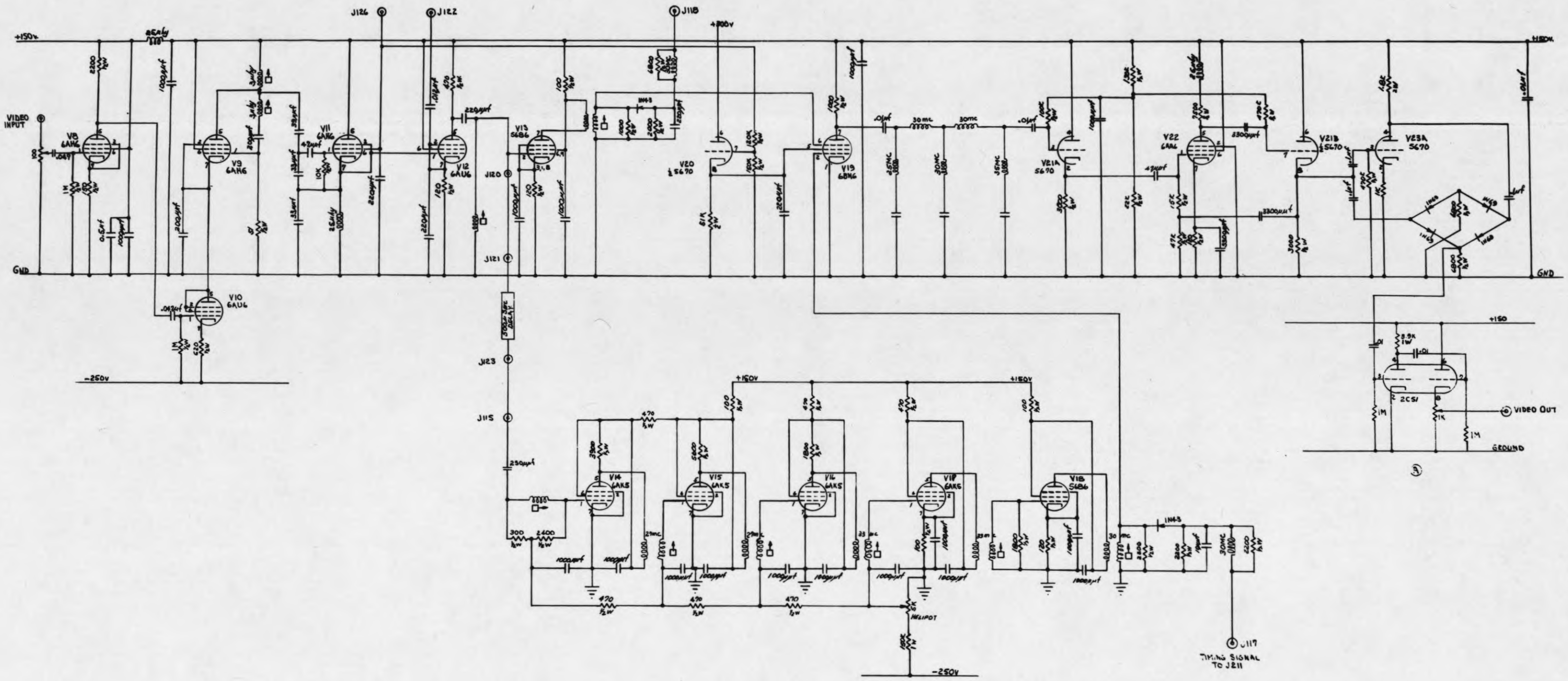


CONFIDENTIAL

DETECTION OF MOVING TARGET



CONFIDENTIAL



CONFIDENTIAL

NOTES:
ADAPTED FROM HUGHES ACFT DWNG. 500A-101-0002
USE THIS DWNG. WITH CSL DWNG D-7092,
"TIMING CIRCUIT"
DIODE MARKING PLATE CATHODE

REV.	BY	DATE	
A	DEB	5-25-58	UNIVERSITY OF ILLINOIS CONTROL SYSTEMS LABORATORY
			DELAYED AND UNDELAYED CHANNELS OF FM CANCELLATION UNIT
			DATE 5-14-58 / SCALE NONE
			DRAWN BY DEB / No. D-7094
			CHECKED BY G.S.A.

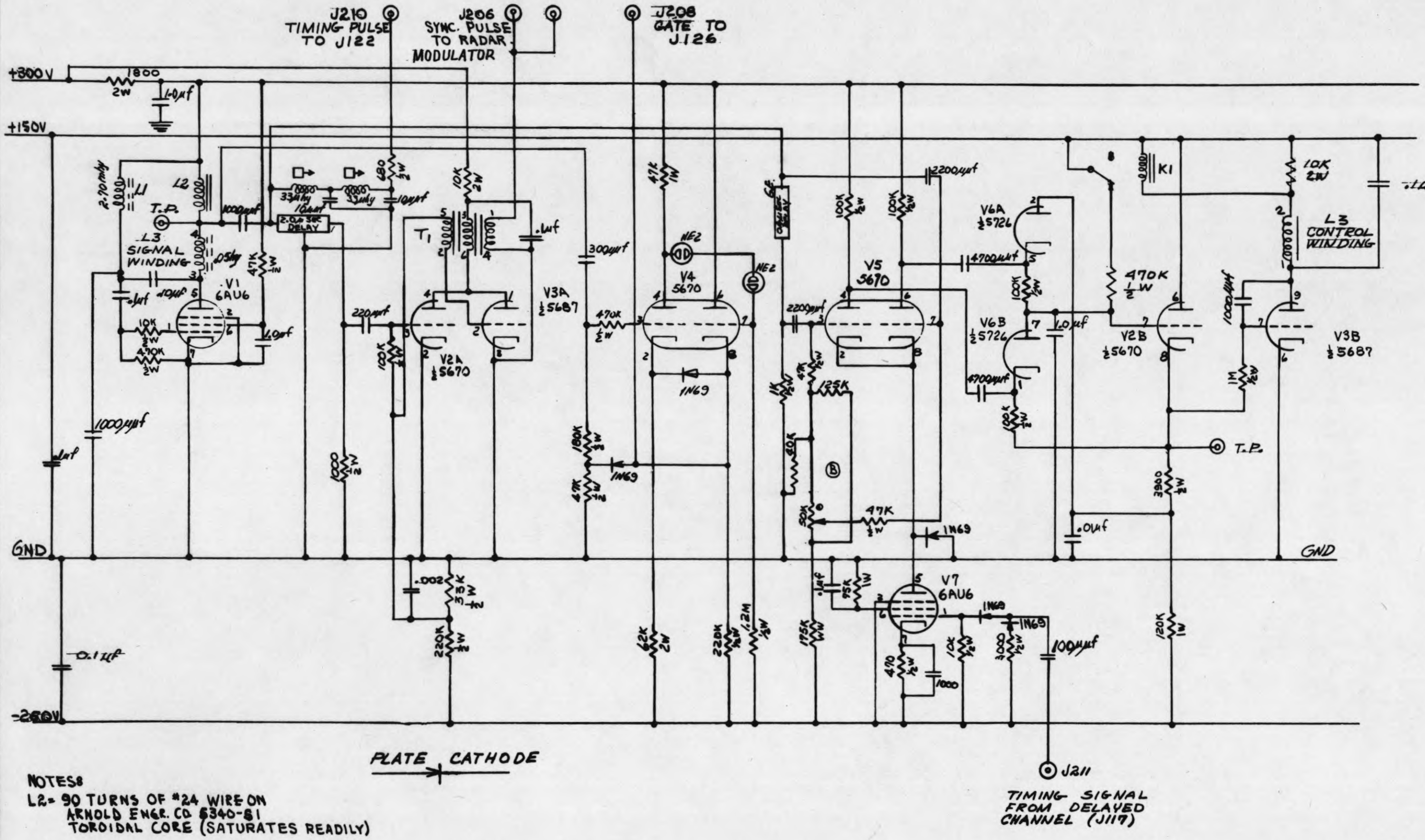


PLATE → CATHODE

NOTES:

L2 = 90 TURNS OF #24 WIRE ON ARNOLD ENGR. CO. 5340-S1 TOROIDAL CORE (SATURATES READILY)

L3 IS HYCOR CO. TYPE NO. 4093

1N43 MAY BE USED IN PLACE OF 1N69

L1 200 TURNS #24 WIRE ON ARNOLD A 206068-2 CORE

2.0 μs DELAY CONSISTS OF 4 FEET G.E. 1000 Ω LINE

T1 IS CHICAGO TRANSFORMER CO. 10111-F

K1 IS ALLIED CONTROL SKHX 339 OR EQUAL

USE WITH DWG. D-7094
ADAPTED FROM HUGHES ACFT. DRAWING 500A-101-0002

REV.	BY	DATE	
A	DEB	7/17/53	UNIVERSITY OF ILLINOIS CONTROL SYSTEMS LABORATORY
B	DEB	5-25-54	TIMING CIRCUIT FOR FM CANCELLATION UNIT
			DATE 9-11-53. SCALE NONE.
			DRAWN BY D.E.B.
			CHECKED BY [signature] No. C-7092

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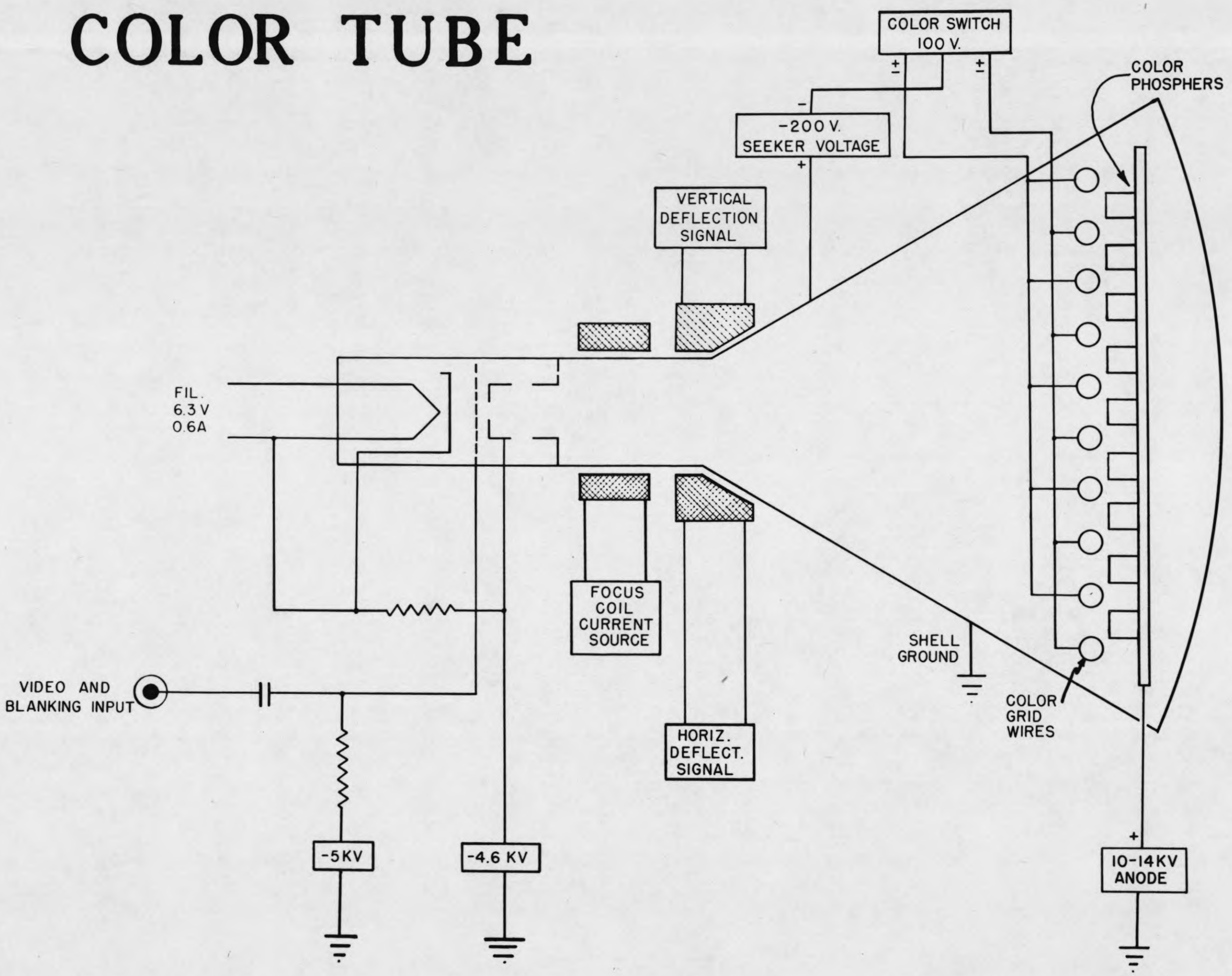
SCHEMATIC OF COLOR TUBE



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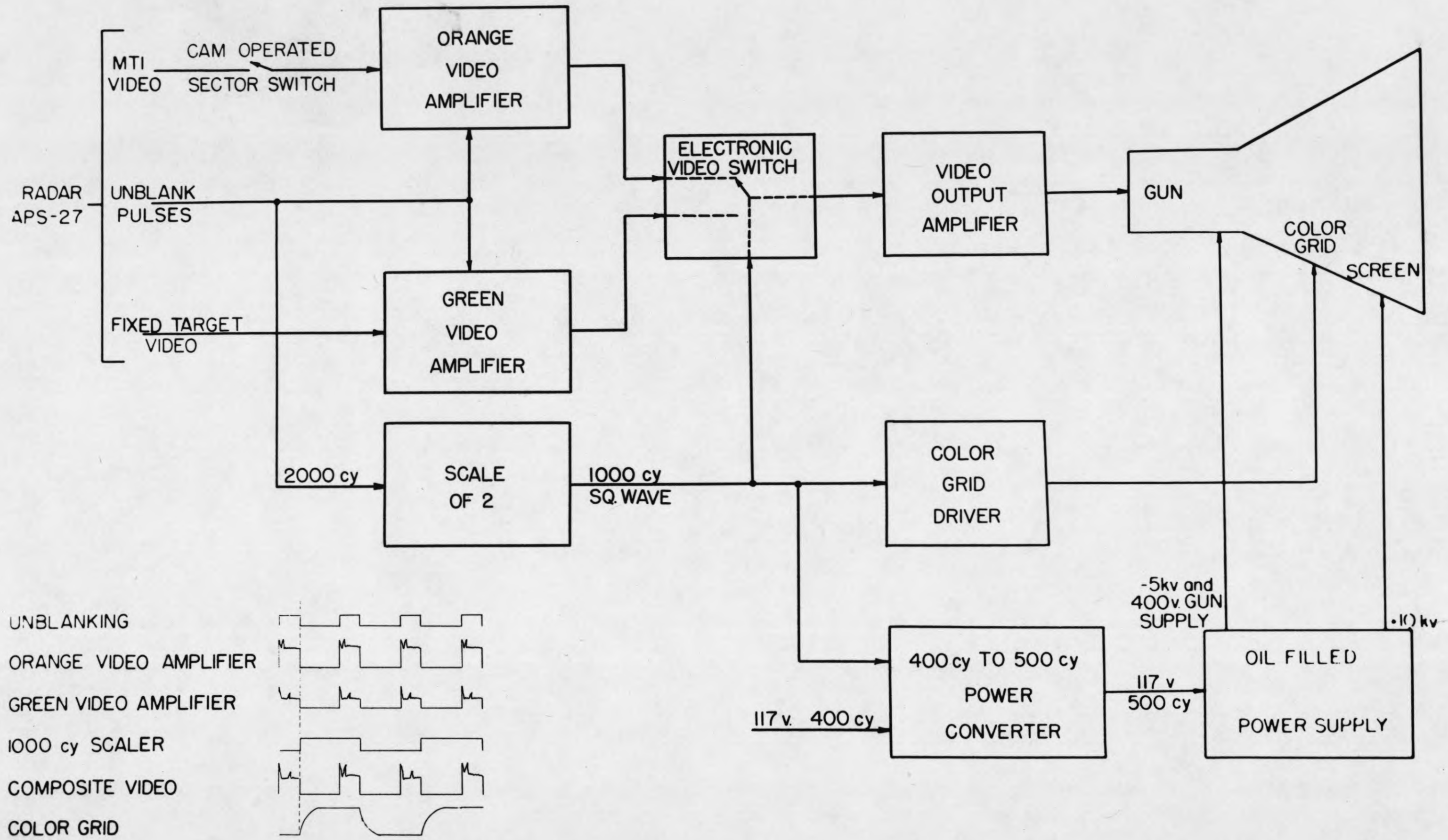
BLOCK DIAGRAM-TWO COLOR PPI



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AWA PARAMETERS

(Search Radar)

Antenna (APS-23)

Elevation - - - - - - csc^2 with depression angle from -6° to -35° having no variation in pattern to exceed 4 db in any 10° interval.

Azimuth - - - - - - Beam width at -3 db point not more than 1.5° total angle, beam width at - 10 db point not more than 2.8° total angle and all minor lobes to be at least 13 db down. Total gain in direction of maximum response shall be 30 db or better.

Wave length - - - - - - - - - - X-band
Pulse length- - - - - - - - - - 3/8 microsecond
Magnetron - - - - - - - - - - - 4J52
Peak Power- - - - - - - - - - - 50 KW Nominal
Klystron- - - - - - - - - - - - 2K25
Azimuth Limits- - - - - - - - - $\pm 90^\circ$
Elevation Tilt- - - - - - - - - $+ 5^\circ$ to $- 15^\circ$. At 0° angle of ant, "pillbox" is 23° below horizontal
Stabilization - - - - - - - - pitch and roll
Servodrive- - - - - - - - - - - Electric
PRF - - - - - - - - - - - - - - 2000 cps
Antenna Rates

Slow scan - - - - - - 4-8 1/2 RPM
Fast scan - - - - - - 15-26 RPM
Sector scan - any angle - any heading

Amplitude-Time

Jitter of received video - - - - - - - - less than 1 milli-microsecond

Receivers - - - - - - - - - - - linlog and linear
Cancellation Unit - - - - - - Modified Hughes F.M. delay line

db of cancellation - operational - 35 db
FM carrier frequency - 30 M.C.
db loss in delay line - 48 db

Average Power - - - - - - - - 44 db above 1 milliwatt

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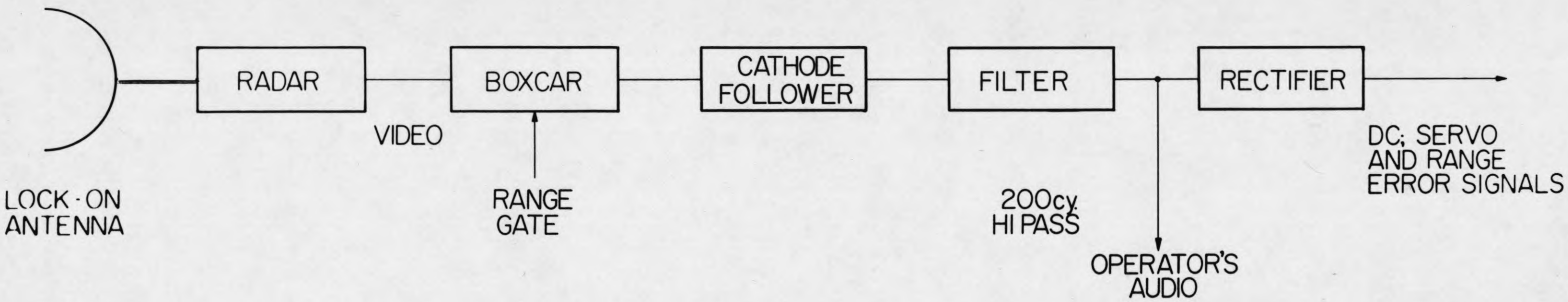
BLOCK DIAGRAM OF
BUTTERFLY TRACKING CHANNEL



FOR THE MONOPULSE TRACKING RADAR
SIX IDENTICAL CHANNELS ARE REQUIRED

[UP DOWN] [LEFT RIGHT]

[EARLY LATE]

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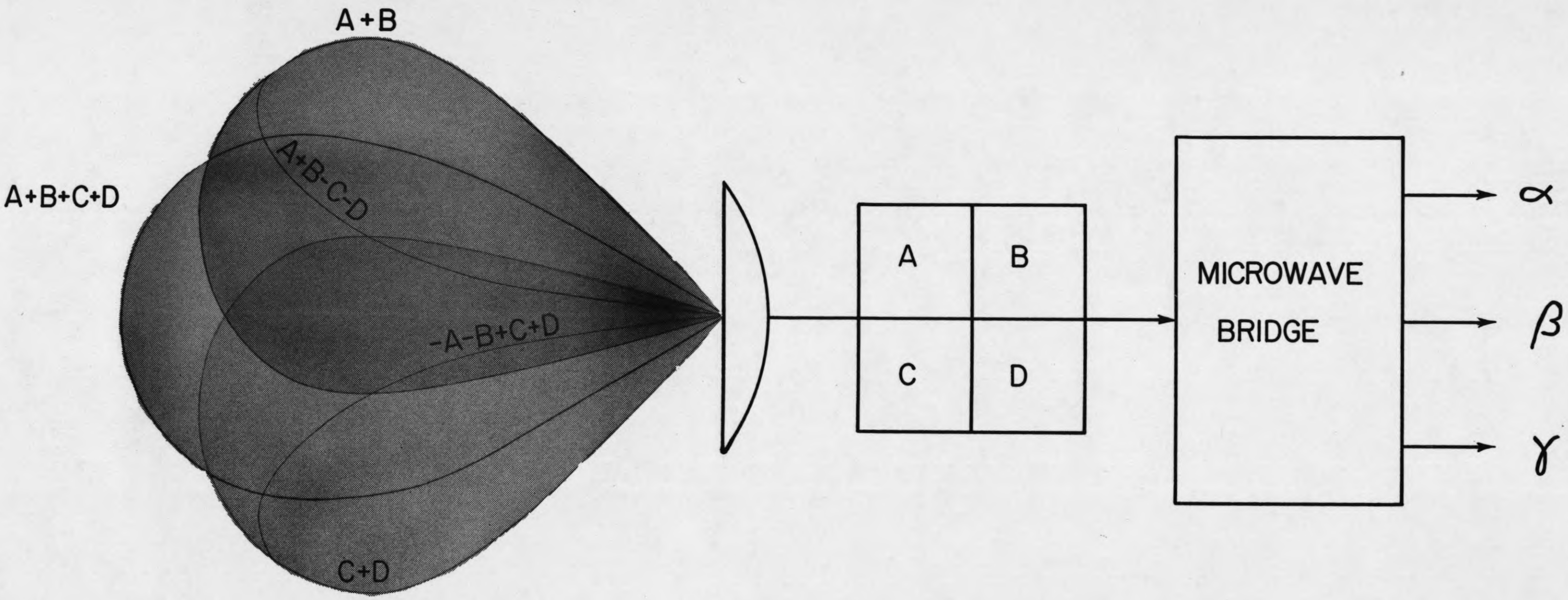
DERIVATION OF MTI ERROR SIGNALS FROM MONOPULSE ANTENNA



SUM, r.f.	α	$= A+B+C+D$
AZIMUTH r.f. ERROR	β	$= A+B-C-D$
ELEVATION r.f. ERROR	γ	$= A+C-B-D$
RIGHT TARGET SIGNAL	μ	$= \alpha + \beta$
LEFT TARGET SIGNAL	ν	$= \alpha - \beta$
AZIMUTH ERROR	Δ	$= \mu - \nu$

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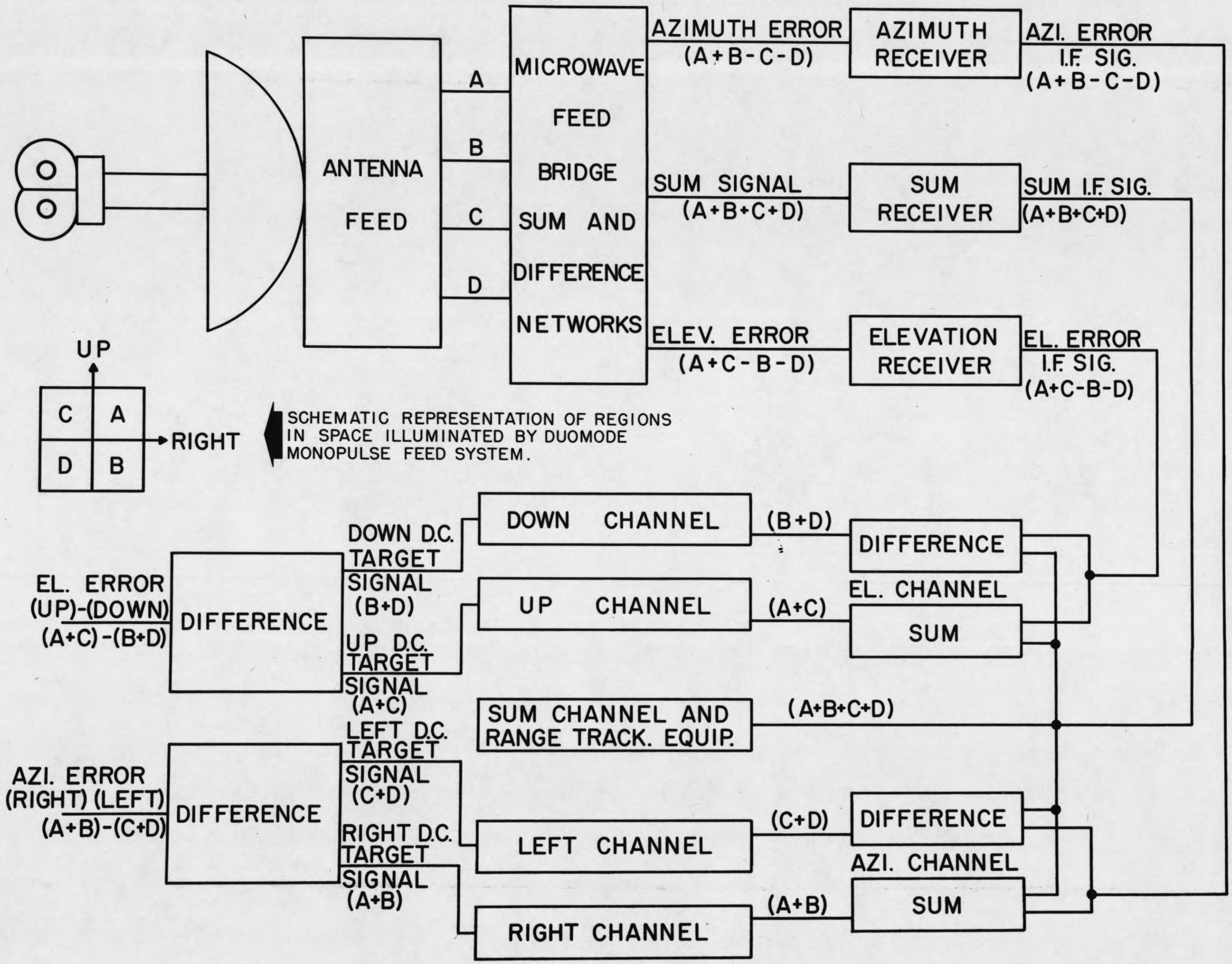

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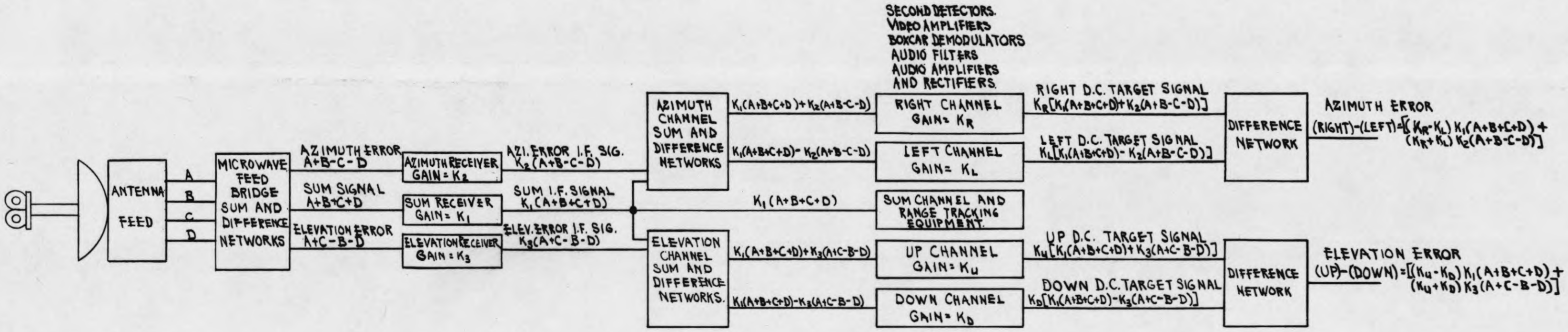

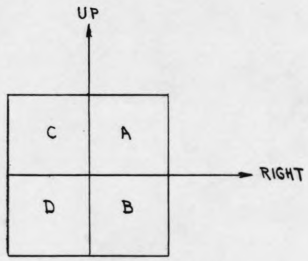

SCHEMATIC REPRESENTATION OF REGIONS IN SPACE ILLUMINATED BY DUOMODE MONOPULSE FEED SYSTEM

NOTE: IF $K_R = K_L$ AND $K_U = K_D$
THEN AZ ERROR = $2K_R K_2$ (A+B-C-D)
AND EL ERROR = $2K_U K_3$ (A+C-B-D)
∴ THE 3 RECEIVERS DO <u>NOT</u> HAVE TO BE IDENTICAL

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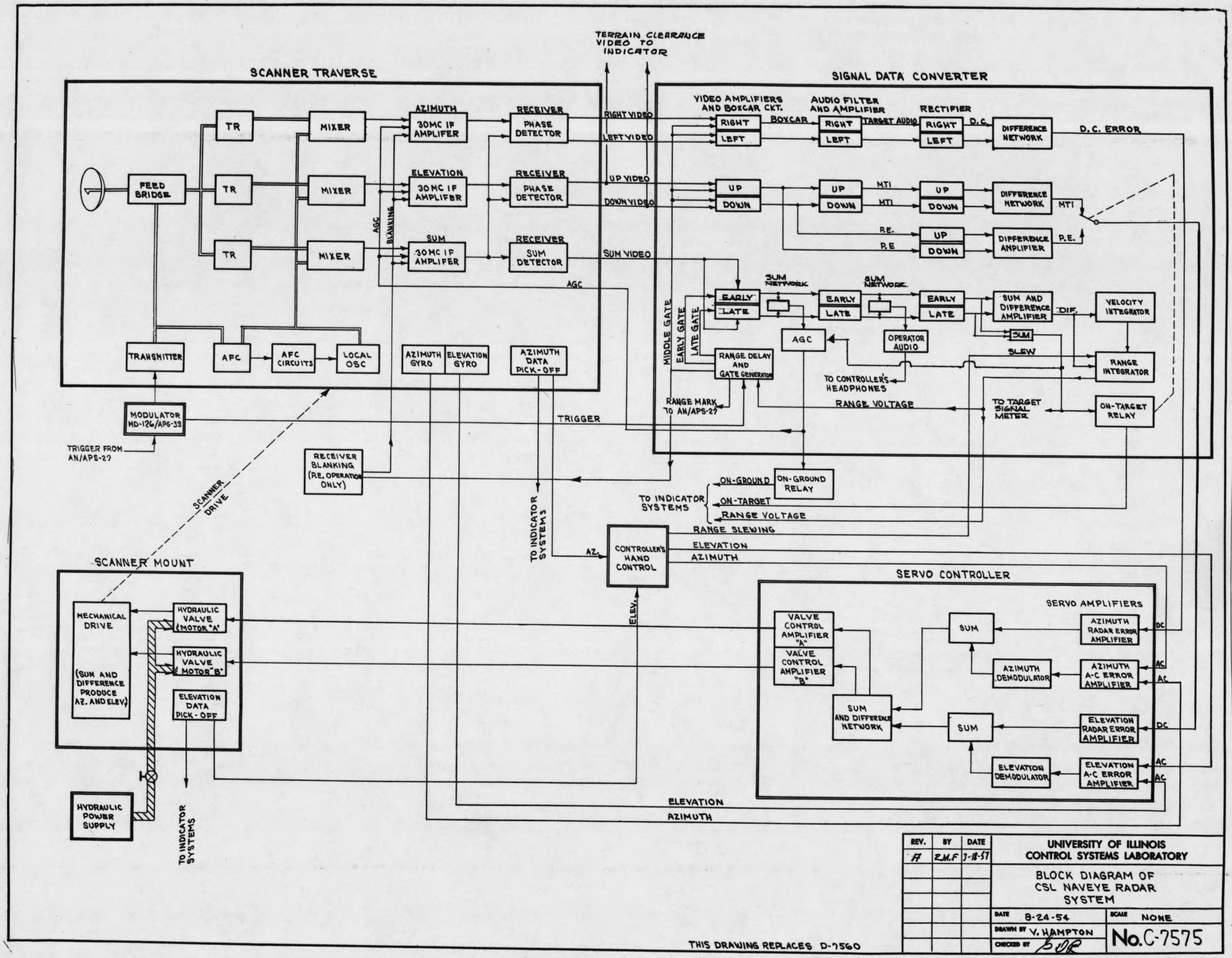
REV.	BY	DATE	UNIVERSITY OF ILLINOIS CONTROL SYSTEMS LABORATORY
			BLOCK DIAGRAM OF ANTENNA ERROR PROCESSING CHANNELS FOR C.S.L. HAVEYE SHOWING INDEPENDENCE OF RECEIVER GAINS, K_1, K_2, K_3.
			DATE 8-17-53 SCALE NONE.
			DRAWN BY DEB
			CHECKED BY WWK No.C-7532.

CONFIDENTIAL



REV.	BY	DATE
A	Z.M.F	3-18-57

UNIVERSITY OF ILLINOIS
CONTROL SYSTEMS LABORATORY

BLOCK DIAGRAM OF CSL NAVEYE RADAR SYSTEM

DATE 8-24-54 SCALE NONE
DRAWN BY V. HAMPTON
CHECKED BY [signature]
No. C-7575

THIS DRAWING REPLACES D-7560

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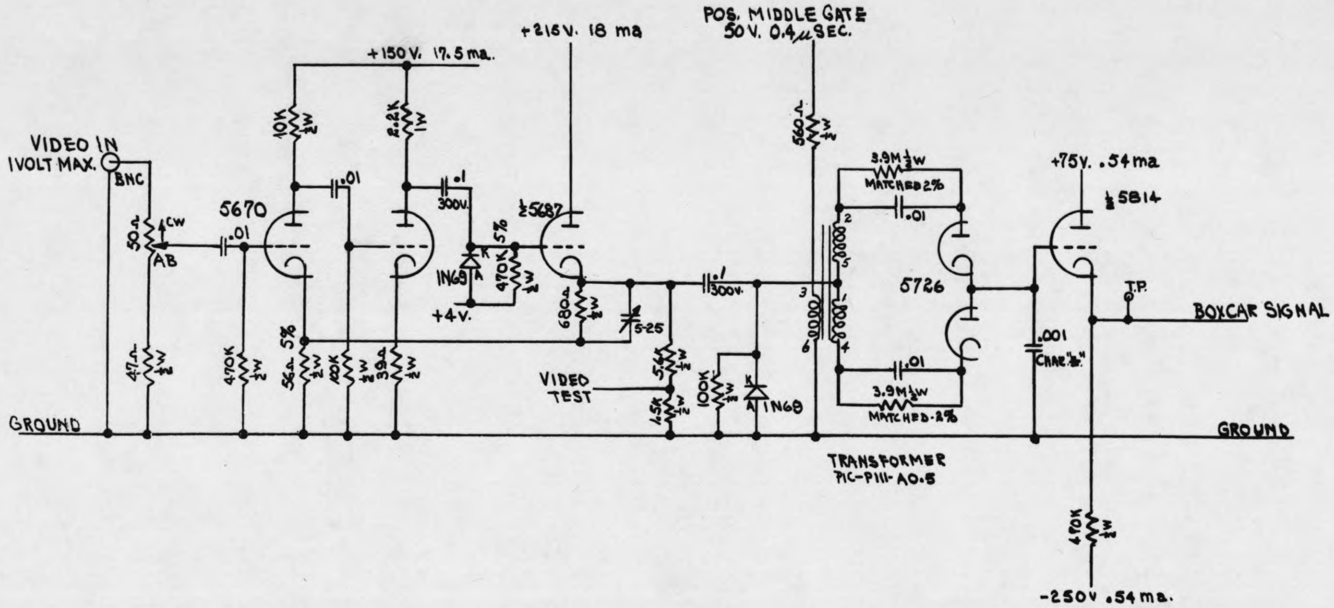
REV.	BY	DATE	UNIVERSITY OF ILLINOIS CONTROL SYSTEMS LAB.
			SIMPLIFIED SCHEMATIC VIDEO AMPLIFIER- BOXCAR. FOR AZIMUTH AND ELEVATION CHANNELS.
			DATE: 4-30-53. SCALE- NONE
			DR. BY: DEB
			CH. BY: NWR
			NO. B-7504



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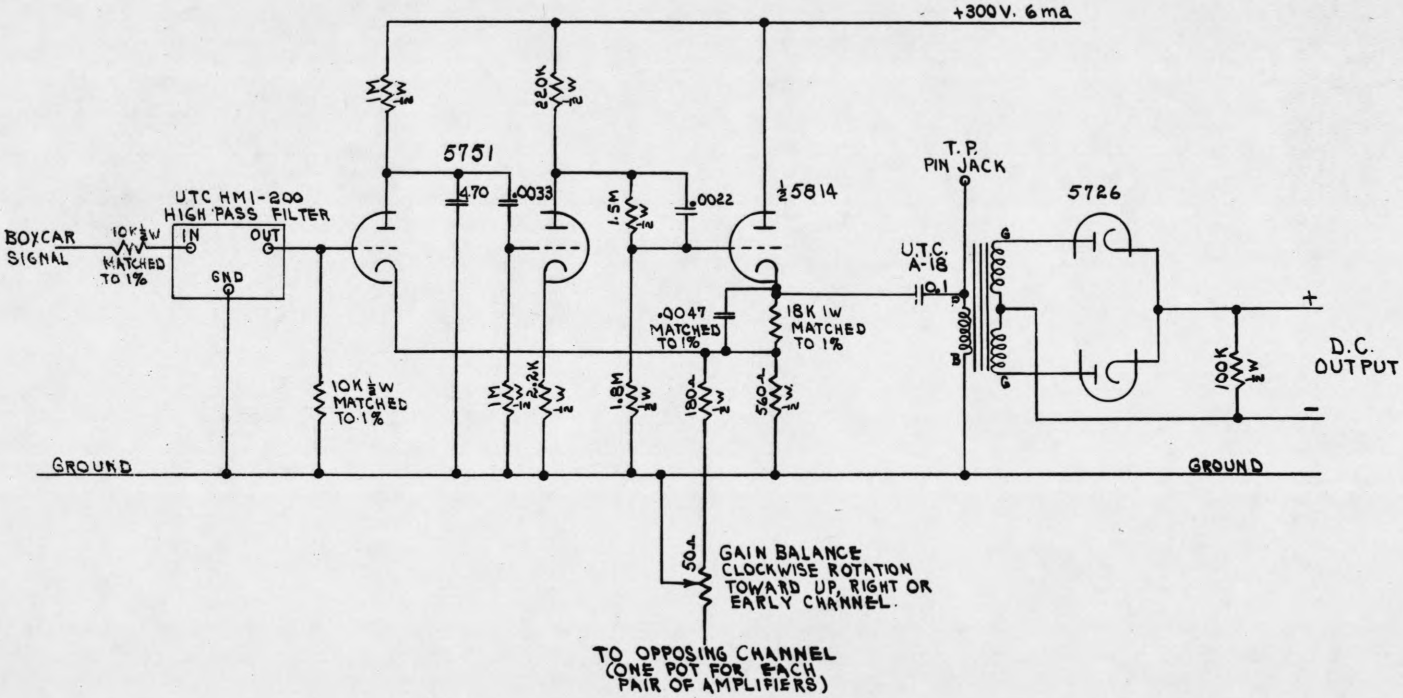
REV.	BY	DATE

UNIVERSITY OF ILLINOIS
CONTROL SYSTEMS LAB

SIMPLIFIED SCHEMATIC
AUDIO TARGET FILTER AMPLIFIER

DATE: 5-1-53	SCALE: NONE
DR.BY: DEB	NO. B-7505
CH.BY: [illegible]	

NOTE:
MATCHED COMPONENTS ARE WITH REGARD TO OPPOSING CHANNELS.



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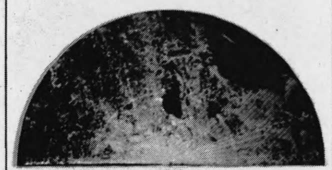
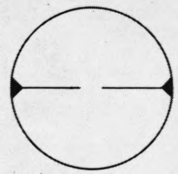
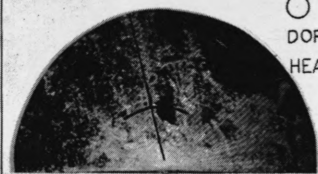
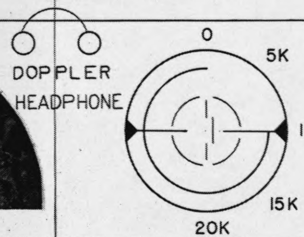
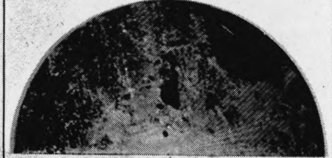
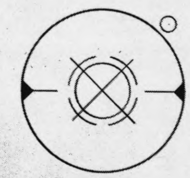
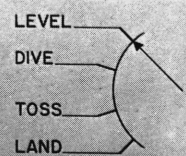
A.W.A. SYSTEM OPERATIONAL PROCEDURE

	CONTROLLER	PILOT	CONTROLLERS P.P.I.	PILOT'S SCOPE
TARGET DETECTION	NAVIGATES. SELECTS TARGET.	MONITORS TERRAIN CLEARANCE.		
TARGET ACQUISITION	GRASPS HAND CONTROL. DEPRESSES ACTION SWITCH. LOCKS ON GROUND IN EL. CONTROLS RANGE AND AZIMUTH. HEARS DOPPLER TONE. RELEASES ACTION SWITCH FOR AUTO-TRACK.	WAITS FOR DOPPLER TONE IN HEADSET. MAINTAINS LEVEL FLIGHT.		
TARGET TRACKING	MONITORS TRACKING RUN. EXPANDS SCOPE DISPLAY. STUDIES SCOPE FOR TERRAIN AVOIDANCE DATA.	STEERS AIRCRAFT TO ZERO STEERING SIGNALS.		
ORDNANCE RELEASE	PREPARES TO REPEAT SEQUENCE.	PULLS AWAY FROM TARGET. TERRAIN AVOIDANCE PICTURE COMING NEXT.		

NOTE: SYSTEM AUTOMATICALLY REVERTS TO TARGET DETECTION MODE UPON:
(a) ORDNANCE RELEASE
(b) LOSS OF TARGET BY LOCK-ON RADAR
(c) INTENTIONAL ABORT BY OPERATOR



CONTROLLER'S ATTACK SELECTOR

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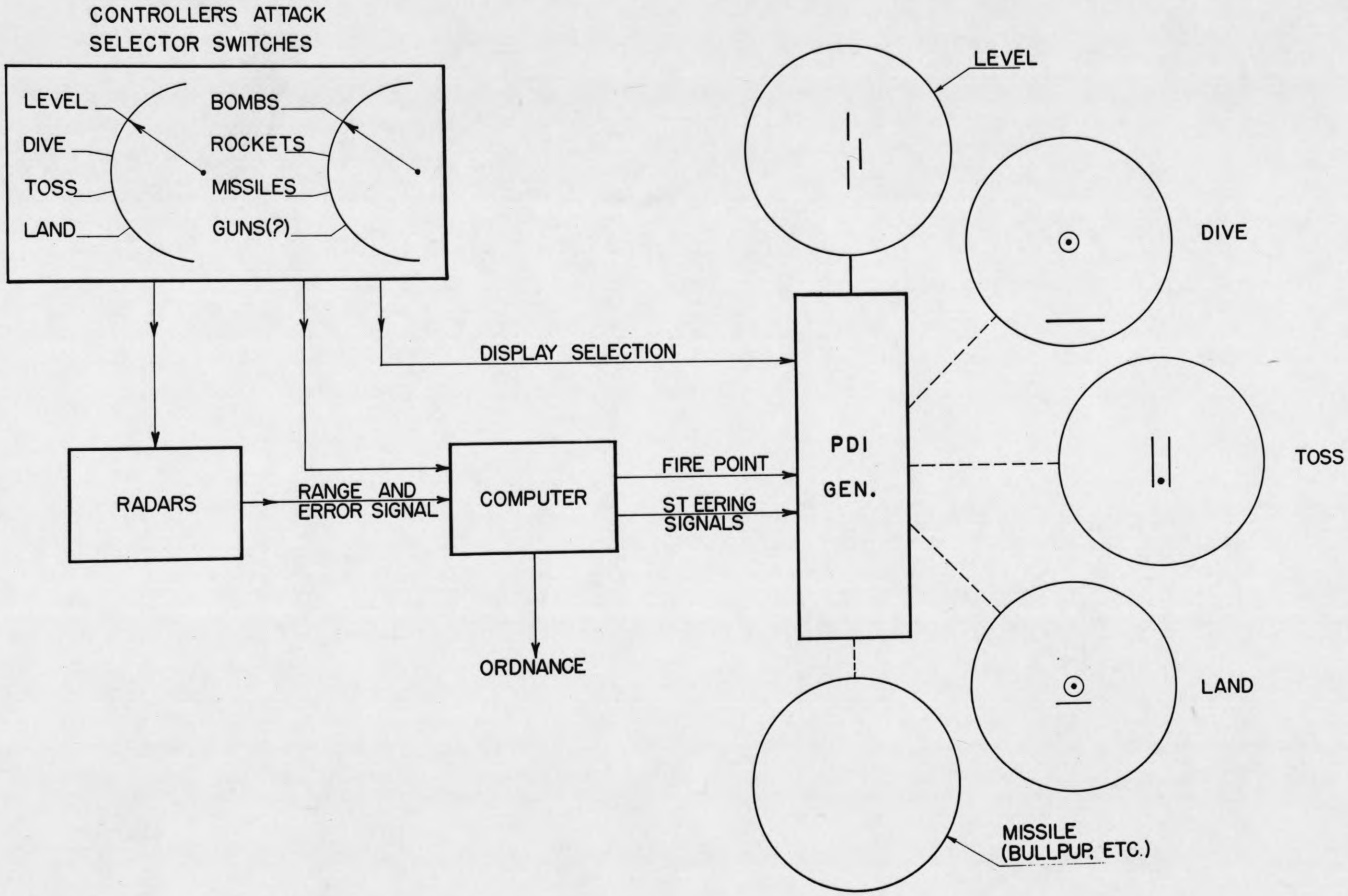
ATTACK MODE & STORES SELECTION



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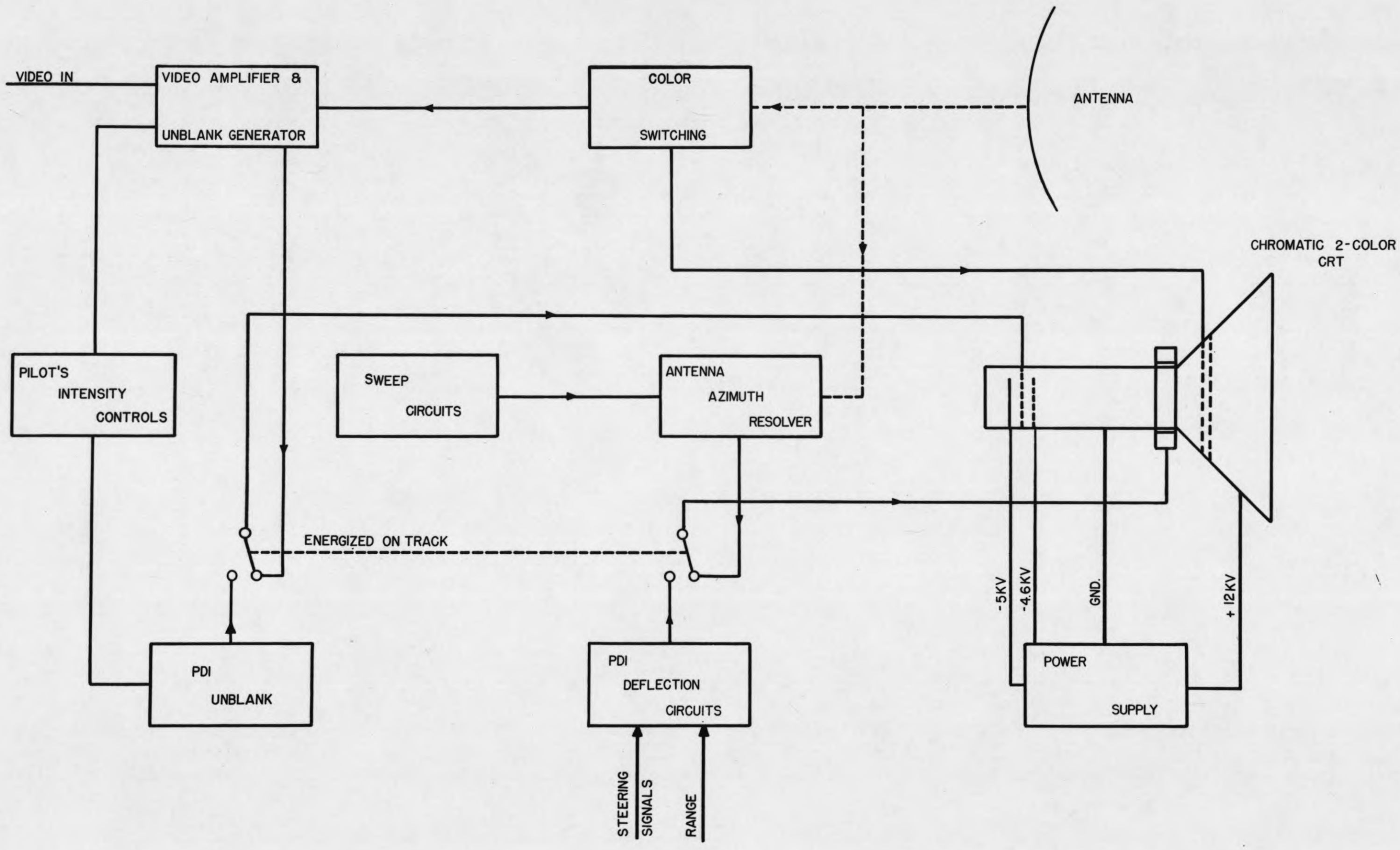
BLOCK DIAGRAM OF PILOT'S DISPLAY SYSTEM FOR TERRAIN CLEARANCE & PDI



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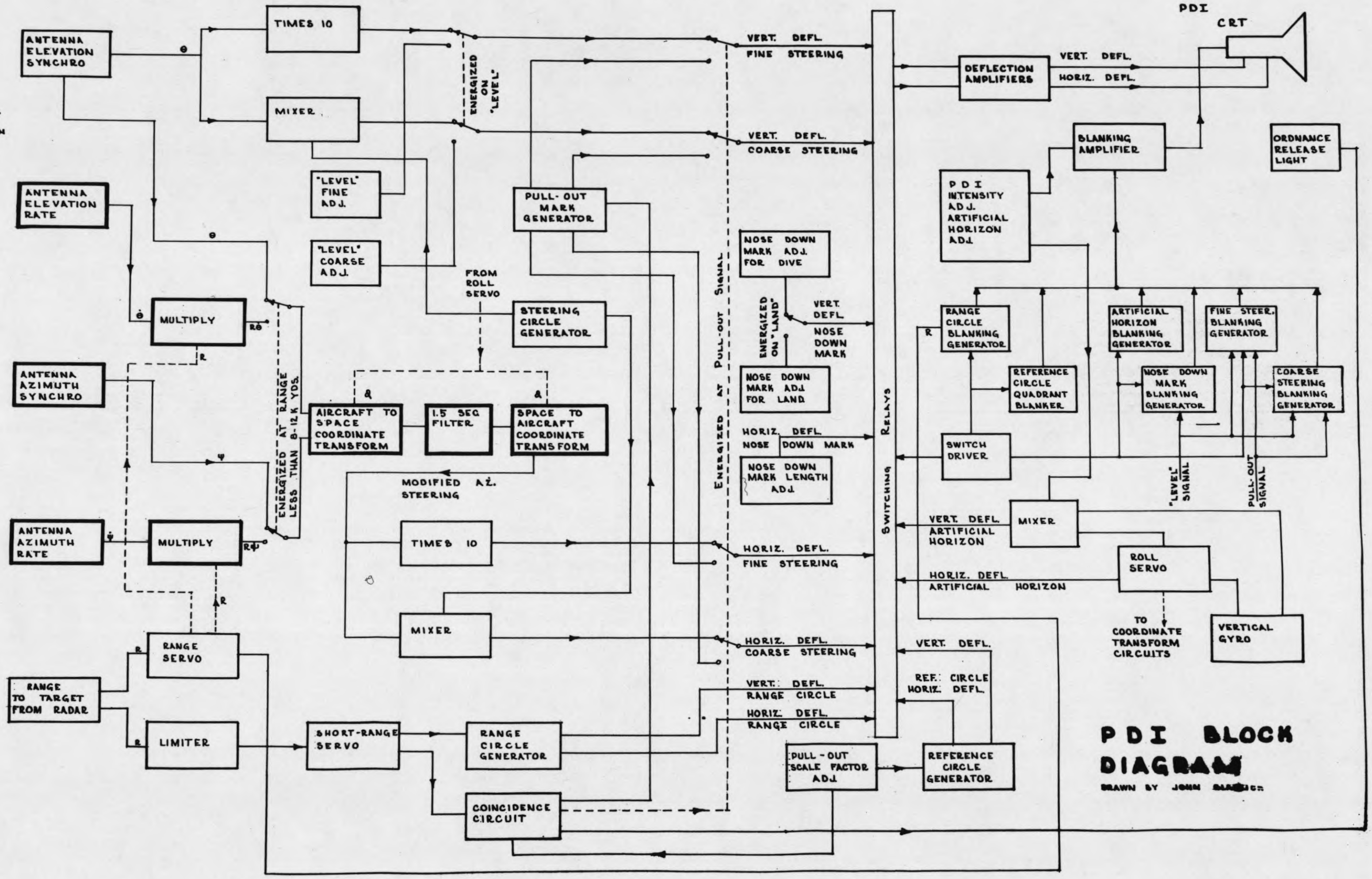

PDI BLOCK DIAGRAM

DRAWN BY JOHN [illegible]

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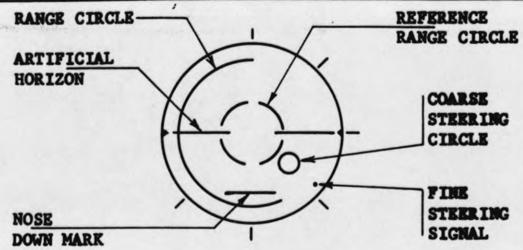
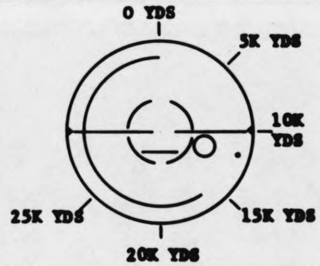
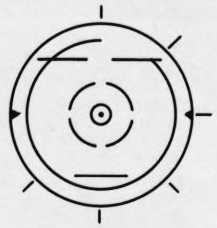
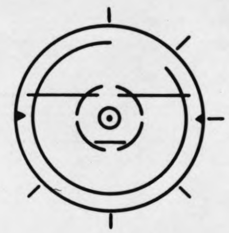
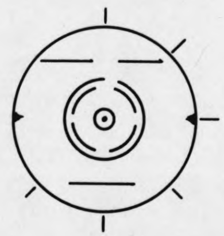
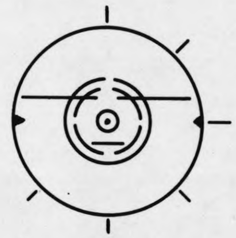
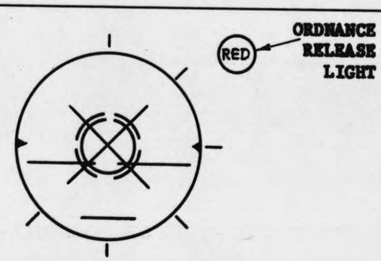
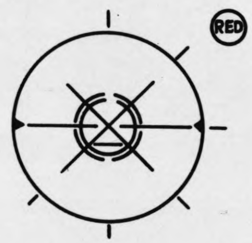
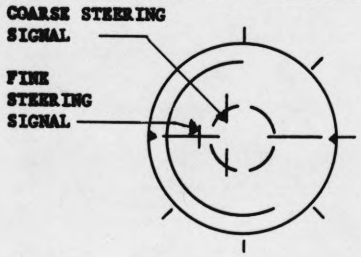
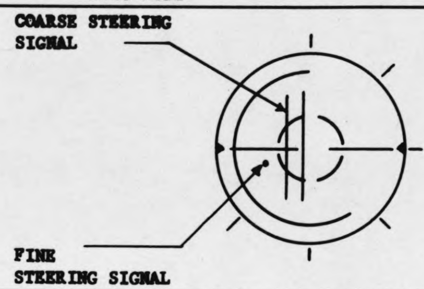
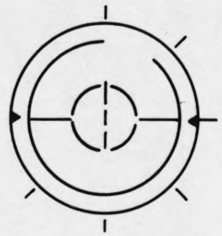
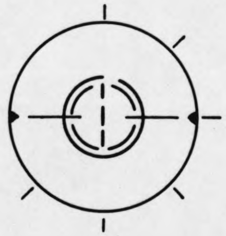
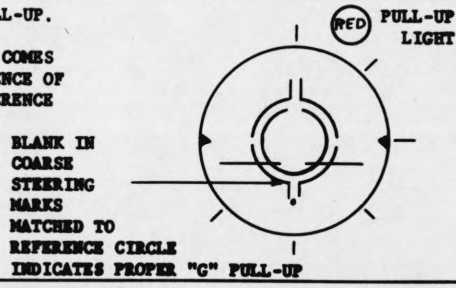
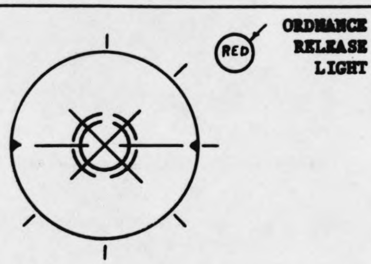
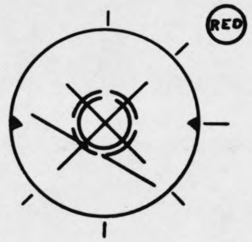
PILOT'S DISPLAY SEQUENCES

	DIVE MODE		LANDING MODE	
BEGINNING OF TRACKING RUN	BLANKED SECTION OF RANGE CIRCLE SHOWS SLANT RANGE TO TARGET. PLANE IS IN LEVEL FLIGHT. STEERING SIGNALS CALL FOR A RIGHT CORRECTION. TARGET IS BELOW AIRCRAFT, BUT IS NOT YET DEPRESSED TO NOSE DOWN ANGLE.		TARGET (PARKED HELICOPTER OR ROTATING CORNER REFLECTORS) IS BELOW AND ON THE RIGHT. NOSE DOWN MARK IS SET FOR 3 DEGREE ANGLE OF GLIDE.	
ON FINAL APPROACH	AIRCRAFT IN DIVE. STEERING SIGNALS ZEROED. RANGE HAS CLOSED TO 5000 YARDS		AIRCRAFT IN GLIDE.	
JUST BEFORE FIRE POINT	RANGE CIRCLE HAS COLLAPSED FROM 3 TIMES FIRE POINT RANGE TO NEAR COINCIDENCE WITH REFERENCE CIRCLE. FIRE POINT COMING UP.			
PULL OUT	RELEASE LIGHT ENERGIZED AT COINCIDENCE. PULLOUT "X" OCCURS ONE SECOND LATER.		AIRCRAFT LEVEL. RUNWAY LIGHTS SHOULD BE VISIBLE.	

PILOT'S DISPLAY SEQUENCES

	LEVEL MODE		TOSS MODE	
BEGINNING OF TRACKING RUN	AIRCRAFT IN LEVEL FLIGHT. STEERING SIGNALS CALL FOR LEFT CORRECTION. RANGE TO TARGET: 17,000 YARDS.			
ON FINAL APPROACH	STEERING SIGNALS ZEROED. RANGE HAS CLOSED TO 5,000 YARDS.			
JUST BEFORE FIRE POINT	RANGE CIRCLE HAS COLLAPSED FROM 3 TIMES FIRE POINT RANGE TO NEAR COINCIDENCE WITH REFERENCE CIRCLE.		JUST AFTER PULL-UP. PULL-UP LIGHT COMES ON AT COINCIDENCE OF RANGE AND REFERENCE CIRCLES.	
PULL OUT	RELEASE LIGHT ENERGIZED AT COINCIDENCE. PULLOUT "X" OCCURS ONE SECOND LATER		STORES AWAY AND PULL-OUT.	

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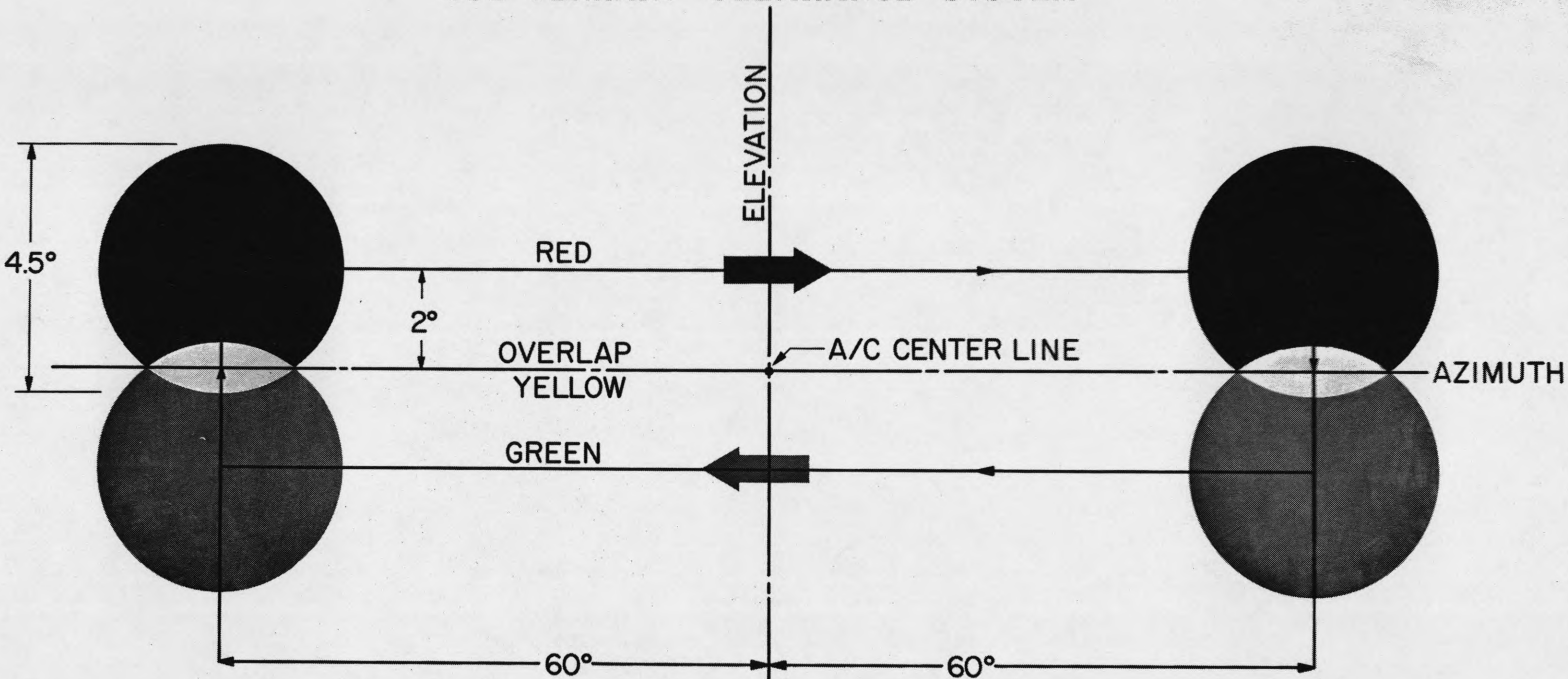
ANTENNA SCAN PATTERN

CSL TERRAIN CLEARANCE SYSTEM



THE MONOPULSE MAY PROVIDE BOTH COLORS SIMULTANEOUSLY WITH A SINGLE BAR SCAN

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CSL TERRAIN CLEARANCE SYSTEM BLOCK DIAGRAM

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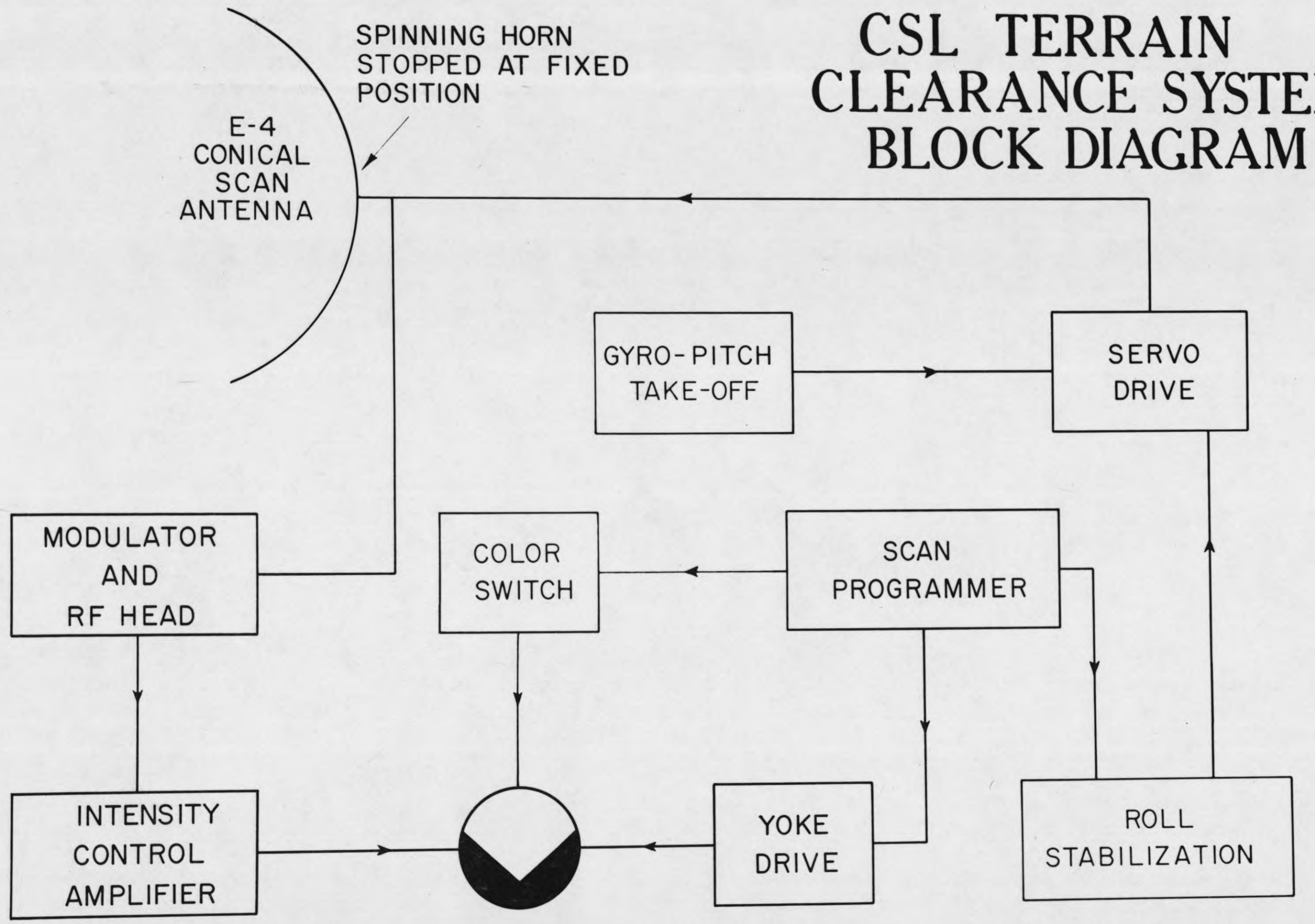

NOTE:
RED ------------------RETURN ABOVE FLIGHT LINE
YELLOW------------RETURN ON FLIGHT LINE
GREEN --------------RETURN BELOW FLIGHT LINE
SCOPE TUBE ---- CHROMATIC TELEVISION LABS (MODEL PDF 10-1X)

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TERRAIN CLEARANCE PERFORMANCE SLIDES

AWA PARAMETERS

(Tracking Radar)

Antenna - - - - - - - - - - - - -	4 lobe monopulse, N.A.A. "NAVEYE" (These data also apply in general to Hughes E-4 conical scan which was also used.)
Peak Power - - - - - - - - - -	50 KW Nominal 32 KW Typical
Beam Width - - - - - - - - - -	3.5°
Pulse Length - - - - - - - - -	0.5 micro sec
Gate Length - - - - - - - - - -	0.4 micro sec
Early	0.2 micro sec lead
Late	0.2 micro sec lag
Magnetron - - - - - - - - - - -	2J55 or 2J56
Klystron - - - - - - - - - - -	2K25
Dish Size - - - - - - - - - - -	25 inch Parabola
Azimuth Limits - - - - - - - -	$\pm 56^{\circ}$
Elevation Limits - - - - - - -	$\pm 56^{\circ}$
Stabilizations - - - - - - - -	
Elevation	$\pm 56^{\circ}$
Azimuth	$\pm 56^{\circ}$
Servo Drive - - - - - - - - -	Hydraulic (Conical Scan - electric)
P.R.F. - - - - - - - - - - - - -	2 KC
Receiver - - - - - - - - - - -	Linear
Range Jitter - - - - - - - - -	1 milli-micro sec
Amplitude Jitter of Received Video - - - - - - Overall System	1 % of normal video output
AGC Time Constant - - - - - -	Closed loop corner frequency $\approx$ 100 cycles per sec
Band pass of servo loop - -	3 cycles
Band pass of gyro loop - -	20 cycles
Band pass of range track loop - - - - - - - - - - -	
(a) Acquisition	100 cycles per sec
(b) Track	20 cycles per sec (Provides range rate memory)
Max. Antenna Rate - - - -	30° per sec
Beam separation - - - - - - -	2.3°
Range Tracking error- - - -	Better than $\pm$ 25 yards
Angle Tracking error- - - -	3 milliradians RMS
Overall System Noise Figure	3 % (Preferably 1 %)

(NOTE: % of 100 % Modulated target. A 3 % target would be lost in noise.)

Unclass.

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VARIOUS TECHNICAL PARTICULARS AND IMPLICATIONS OF THE AWA SYSTEM

~~CONFIDENTIAL~~

Unclass

late comers - special movie

Color tube data sheets

tube size - reliability - wire vibration

advantage of single gun (YOKE) - line by line

lockon vs search sensitivity
tuning requirements
noise levels

Gyros smooth
time constant
measure rate
for comp
stabilize (reduce burden of track)

Auto pilot, maneuvering

$18^2 = 400$

$- 80$

$+ 4$

324

$20^2 = 400$

$7^2 = 49$

$8^2 = 64$

324
64
388

R. M. S.